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DEVELOPMENT OF A TRIAL AIR QUALITY MAINTENANCE PLAN USING THE BALTIMORE AIR QUALITY CONTROL REGION

Engineering-Science, Incorporated

Prepared for:

Environmental Protection Agency
Howard, Needles, Tammen and Bergendoff

September 1974

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16. ABSTRACT

This report is a Trial Air Quality Maintenance Plan for the Baltimore Air Quality Maintenance Study Area, which is coterminous with the Metropolitan Baltimore Air Quality Control Region. The report contains: A trial analysis of whether the National Ambient Air Quality Standards for particulate matter, sulfur dioxide, photochemical oxidants, and nitrogen dioxide will be maintained for the ten year period 1975-1985; a trial plan to maintain the standards which are not expected to be maintained over that period; and a description of the method used to develop the trial plan. The plan was prepared using draft EPA guidelines concerning air quality maintenance area analysis and plan development and can be used as an example which states can use in developing their analyses and plans pursuant to EPA's requirements contained in 40 CFR Part 51.

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September 1974

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The Air Quality Task Force, Regional Planning Council participated in the development of the Trial Maintenance Plan. Their participation in this Plan was with the understanding that it would not bind the Baltimore Region to a specific data base, method of analysis, or final strategy.

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CHAPTER I

INTRODUCTION

As outlined in the Federal Register (40 CFR 51.12(e)), all states were required to identify those areas of their state that have the potential for exceeding National Ambient Air Quality Standards (NAAQS) as a result of projected growth in emissions over the 10-year period 1975 to 1985. The Baltimore Air Quality Control Region (Figure 1) was so identified.

For this Region it was necessary to prepare and submit the following (40 CFR 51.12(g)):

> "(1) An analysis of the impact on air quality of projected growth and development over the 10-year period from the date of submittal.
>
> "(2) A plan to prevent any national standards from being exceeded over the 10-year period from the date of submittal. Such plan shall include, as necessary, control strategy revisions and/or other measures to insure that projected growth and development will be compatible with maintenance of the national standards throughout such 10-year period."

As a part of the overall air quality planning process for the Baltimore Air Quality Control Region, the Office of Air Programs of the U.S. Environmental Protection Agency contracted with Engineering-Science, Inc. (ES) to evaluate and critique EPA's draft Air Quality Maintenance Plan guidelines. In addition, ES was requested to develop for the Baltimore Air Quality Control Region a prototype air quality maintenance plan. The objectives in developing this trial plan were to test the guidelines, to determine areas of weakness, and to develop recommendations for improvements so that the State and local agencies would be able to develop maintenance plans in a direct and orderly fashion. In addition, it was felt that improved clarity

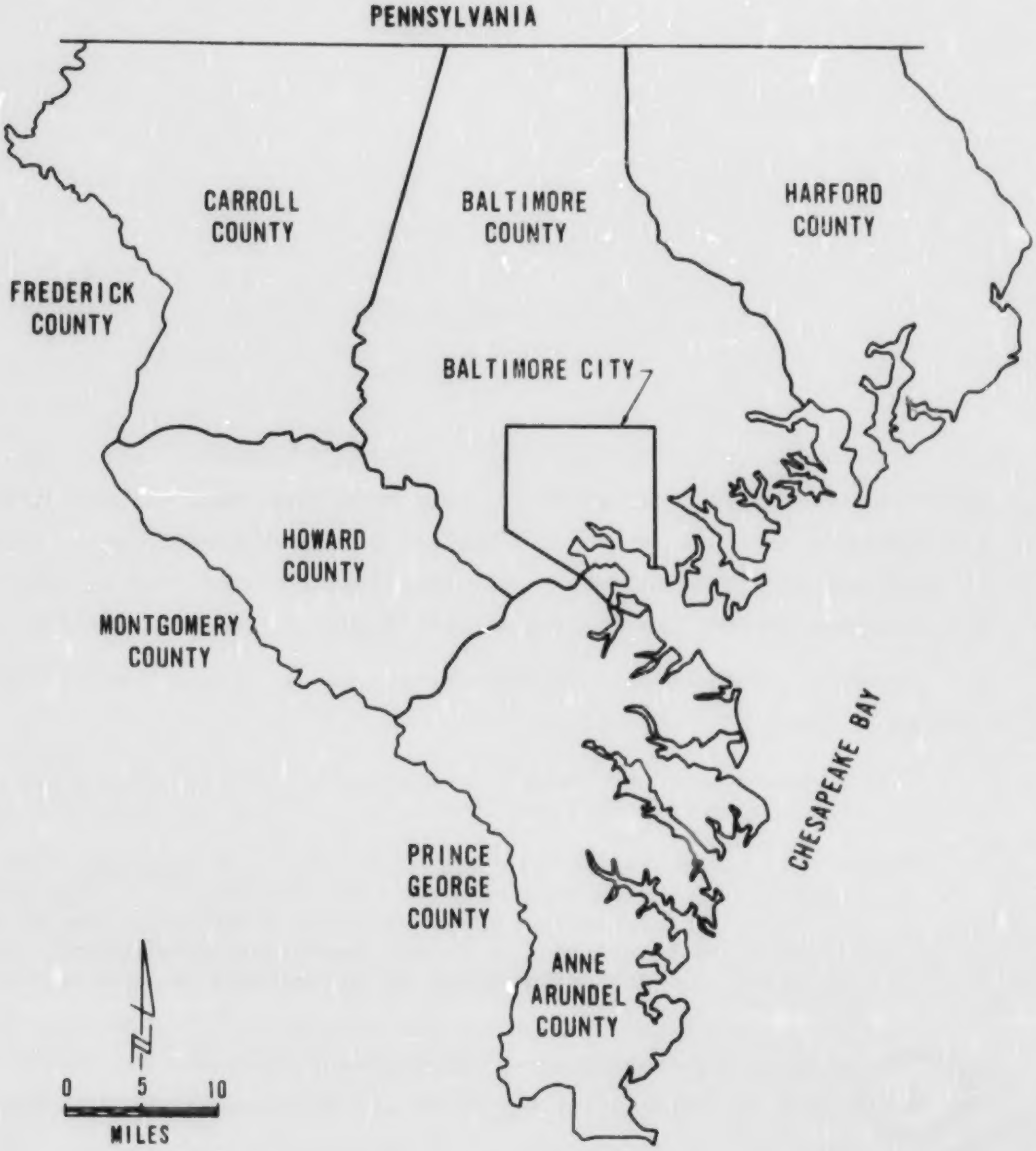
PENNSYLVANIA
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
N
0
5
10
MILES

Figure 1. Baltimore air quality control region

in the guideline documents would result in a more uniform format and would enhance completeness of the plans at the time they were submitted to EPA.

The Baltimore Air Quality Control Region boundaries conform to the Baltimore Standard Metropolitan Statistical Area and encompass 2,364 square miles (Figure 1). Included in the Region are the City of Baltimore and the counties of Anne Arundel, Baltimore, Carroll, Harford, and Howard. The Region forms the western edge of the northern section of Chesapeake Bay. The western portion of the Region lies in the Piedmont Plateau, while the eastern portion lies within the Middle Atlantic Coastal Plain. The eastern portion is generally flat, with elevations of less than 500 feet. Toward the west, the elevation rises gradually to the gently rolling areas of Carroll and Howard Counties where elevations reach 1,000 feet. The topography generally permits free air movement with little channeling effects.

Population of the Region increased 19 percent between 1960 and 1970 to a total of nearly 2.1 million. The 1970 census data indicate that projected growth patterns and population estimates were reasonably accurate except for the City of Baltimore, which was estimated to have lost approximately four percent in population. The population of Baltimore County increased over 26 percent in the same 10-year period and ranked as the most populous county in the State.

Meteorological conditions conducive to the accumulation of air pollutants can and do occur in the Baltimore Metropolitan Area. Topography does not materially restrict free flow of air throughout the Area, but two meterological factors, light winds and a stable temperature lapse rate, occasionally increase the concentrations of air pollution. Clear skies and light winds with stagnant atmospheric conditions lead to the accumulation of pollutants Such conditions usually prevail near the centers of high barometric pressure (anticyclones).

Weather bureau data indicate that inversion conditions occur on short-term bases about 34 percent of the time in the Region. Over a thirty-year interval, the Region averaged 1.5 times per year when stagnation occured that averaged 4.8 days duration. During the same thirty-year period, the region experienced three cases of stagnation that lasted for seven or more days.

This trial air quality maintenance plan was developed on a twenty-week time schedule to aid EPA in meeting certain deadlines. Because time was of the essence, it was not always possible to utilize the guideline documents as working tools for the development of the trial Air Quality Maintenance Plan. Also, the time limitation did not permit extensive coordination with State, regional, or local agencies. Where guidelines or basic issues were lacking or unresolved, the obstacles were noted in the critique, certain assumptions were made (based on the best information available), and preparation of the trial maintenance plan proceeded. In general, this approach met the objective of identifying problem areas which will be common to all planners and control officials attempting to prepare maintenance plans for other areas of the country. For the reasons noted, it is emphasized that this trial maintenance plan is preliminary and will require additional baseline information and detailed consideration of the control measures prior to actual plan preparation by the State.

Four pollutants were considered for analysis in this report [i.e., suspended particulates, sulfur dioxide, oxidant (hydrocarbons) and nitrogen dioxide]. Carbon monoxide was not included in the trial plan. A preliminary analysis based on existing air quality and emission inventory data indicated that the future carbon monoxide levels would not exceed the standards over the 10 year period and therefore should not be considered in the maintenance program.

The time frame in which these air quality maintenance plans were considered to be applicable was 1975 to 1985. The geographic region for which the air quality maintenance plan was developed included: Baltimore City, Baltimore County, Anne Arundel County, Carroll County, Howard County, and Harford County.

To initiate analyses of the need for air quality maintenance plans, ES considered the existing air quality, existing emission inventory, and existing regulations and compliance schedules for reducing various pollutant sources. Maintenance plans were conceptually designed to offset increases in projected emissions as a result of growth through enactment of increasingly stringent control measures (Figure 2). It was therefore assumed that existing regulations would be complied with by 1975 or 1977. However, it was recognized that, in certain cases, i.e. oxidants, the National Secondary

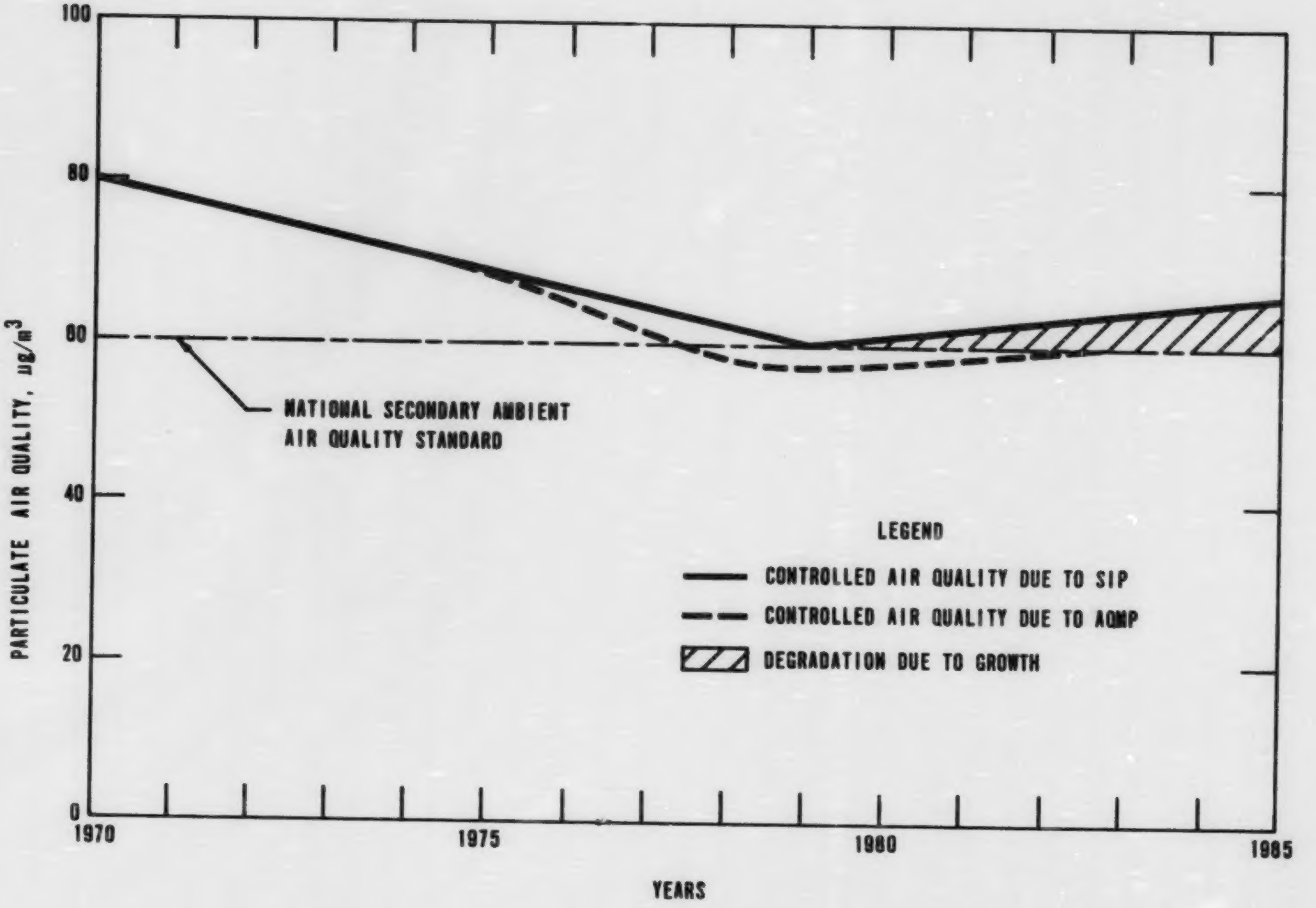

Figure 2. Projected effectiveness of SIP and AQMP

Ambient Air Quality Standards would not be met by the 1975 or 1977 date. In such cases, maintenance strategies theoretically could be selected which would more than compensate for the anticipated growth in emissions. The selected control measures would thereby offer the possibility of eventually replacing currently unacceptable control measures such as gasoline rationing. During preparation of this document, Congress extended the date for additional motor vehicle emission controls to 1977 and limited application of certain measures which had been earlier advocated as hydrocarbon control (VMT) measures; for this analysis, ES assumed that by the year 1985 motor vehicles would be tightly controlled.

The air quality maintenance control measures developed and presented in the report should be considered to be preliminary. The primary value of the document is intended to be a demonstration and test application of the EPA guideline documents rather than a thorough and complete development of a final air quality maintenance plan for the Baltimore Air Quality Control Region. The approach and the experiences cited in this report should be of maximum benefit to the professional planners and air pollution staff members who must develop the air quality maintenance plan for the Baltimore Region.

Control measures considered in this report were reviewed and evaluated by the Baltimore Regional Planning Council's Air Quality Task Force. However, the input of the Task Force to this plan cannot be considered as Regional Council Policy or even as Air Quality Task Force Policy but must be viewed more as the opinion of the various participating members. The input of the participants was to provide Engineering-Science with a feeling for the reaction of public and private groups to the suggested control measures. RPC's participation in this plan was with the understanding that such participation would not bind the Baltimore Region to a specific data base, method of analysis, or final strategy. The background and experience of the Task Force offered a broad-based and wide-ranging viewpoint from State and local officials toward the air quality planning as a part of other and broader long range plans for the Region (a list of Task Force members and those participating in the review and evaluation of control measures is provided in Reference 1 at the end of this chapter. Similar groups should be of value in development of other AQMP's.

In this investigation, the trial air quality maintenance plan was developed so that the National Secondary Ambient Air Quality Standards would be achieved and maintained. The analyses did not attempt to develop plans for achieving or maintaining more stringent ambient air quality standards of the State of Maryland. The four contaminants [suspended particulates, sulfur dioxide, oxidant (hydrocarbons) and nitrogen dioxide] were analyzed separately and results of the analyses appear as four separate chapters in the report. Distinct maintenance measures were suggested for two contaminants, particulates and hydrocarbons, which required reduction over the 1975-1985 period. Areas of overlap or repetition of the control measures were later combined in the maintenance strategies in the last chapter of this report.

The application of air quality models to the analyses required for AQMP's received considerable discussion early in this investigation. The EPA air quality display model was selected to predict air quality for suspended particulate matter and sulfur dioxide. Roll back/roll forward models were utilized for hydrocarbons and nitrogen dioxide. Use of the air quality display model was considered necessary in order to achieve the degree of resolution required to analyze for areas of particularly high concentrations of suspended particulates or sulfur dioxide. Conversely, the roll back/roll forward model was considered adequate in the case of oxidant because the hydrocarbon/oxidant relationship is somewhat uncertain, oxidant is more of an area-wide problem, and photochemical reactions are required.

It became apparent during the conduct of these analyses that projections of 1985 air quality could be highly variable and extremely dependent upon assumptions concerning growth projections. Therefore, the reviewer should temper his judgment of the projections presented in this report with more specific knowledge of the local situation. Otherwise, the sensitivity of the required air quality maintenance measures to the original growth projections could be overlooked. In this trial plan, ES selected control measures which would be as flexible as possible, thus allowing for maintenance of air quality under growth patterns different than anticipated.

In conducting this study, periodic meetings were held with the Regional Planning Council's Air Quality Task Force. In addition several one-on-one meetings were held by ES staff members with state and local officials in the Baltimore Region to obtain data and perspectives on various technical subjects.

In addition to the Introduction, this report includes Chapter II on the actual methodology and approach utilized in the analyses and development of the trial plans. That Chapter is followed by four chapters (III, IV, V, and VI) devoted specifically to the analyses of the need for maintenance plans for each of the four pollutants [i.e., particulate, sulfur dioxide, oxidant (hydrocarbons), and nitrogen dioxide]. Chapter VII described the systematic approach used to identify and consider various maintenance control measures. Chapter VIII identified the control measures and Chapter IX the control strategies which were finally selected. The Appendices contain background data on emissions, traffic, growth projections, etc.

Reference 1-Baltimore Regional Planning Council

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CHAPTER II

DISCUSSION OF METHODOLOGY AND APPROACH

INTRODUCTION

In preparing this plan, ES generally followed the outline in the draft guideline document, "Mechanics of 10-year Plan Preparation and Implementation," developed as Task I under an EPA contract to Research Triangle Institute. However, experience and difficulties encountered in making these analyses are described in this chapter to supplement the guideline document. Alternative approaches are also suggested for the planners or air quality staff who may have sufficient time and resources available to develop a more detailed and thorough AQMP.

The development of this trial plan involved three distinct task areas prior to considering maintenance measures. The remaining portion of this chapter addresses these three basic subject areas: coordination of agencies; review of data base; and analyses of projections. The methodology utilized to identify and rank control measures and to select a control strategy is described in Chapter VII. A diagram showing the flow of tasks in the AQM strategy development process is shown on Diagram 1.

COORDINATION OF AGENCIES

The approach followed in coordinating with state and local agencies and their involvement in the study was dictated by two factors. First, the short time span precluded establishing new and special groups or new relationships. Second, the fact that the work was completed by a consultant to the EPA, rather than by a public agency or by a consultant working for a Maryland Agency precluded operation under a local umbrella.

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There were several aspects to the coordination of project activities. One approach consisted of data collection, technical discussion, and periodic review of the study methodology and results with specific staff of selected agencies. These agencies included all of those listed under the headings federal, state, and regional in the subsequent description of the existing institutional structure. These contacts were an essential part of the planning process. The means of coordination was through the Air Quality Task Force of the Baltimore Regional Planning Council which provided for:

(1) Conveniently informing the "air quality community" of the scope, progress, and findings of the study;

(2) Testing methodology and policy questions with a cross-section of the air quality community;

(3) Establishing contact with the counties through their representation on the task force; and

(4) Obtaining feedback from the counties on the feasibility of various maintenance control measures and strategies discussed in the plan.

The level and breadth of contacts made through the Air Quality Task Force did not fully accomplish the desirable level of coordination with the counties because:

(1) Not all counties were represented at all meetings; and

(2) Representatives had no authority to "speak for the county," nor did they feel comfortable "speaking for the public."

The representative members did, however, relay study alternatives and recommendations to interested parties in the counties and did bring back some response. Within the scope of time and effort available to the study team, it was felt that this was about the best that could be achieved. Certainly it was not possible to relate properly with individual local governments and their agencies.

For any geographic area the existing institutional structure can be divided into private organizations and public agencies (federal, state, regional, and local). During the investigative phase of this project, specific contacts were made with many of the public agencies having direct or peripheral interest in the Baltimore Air Quality Maintenance Plan. These included:

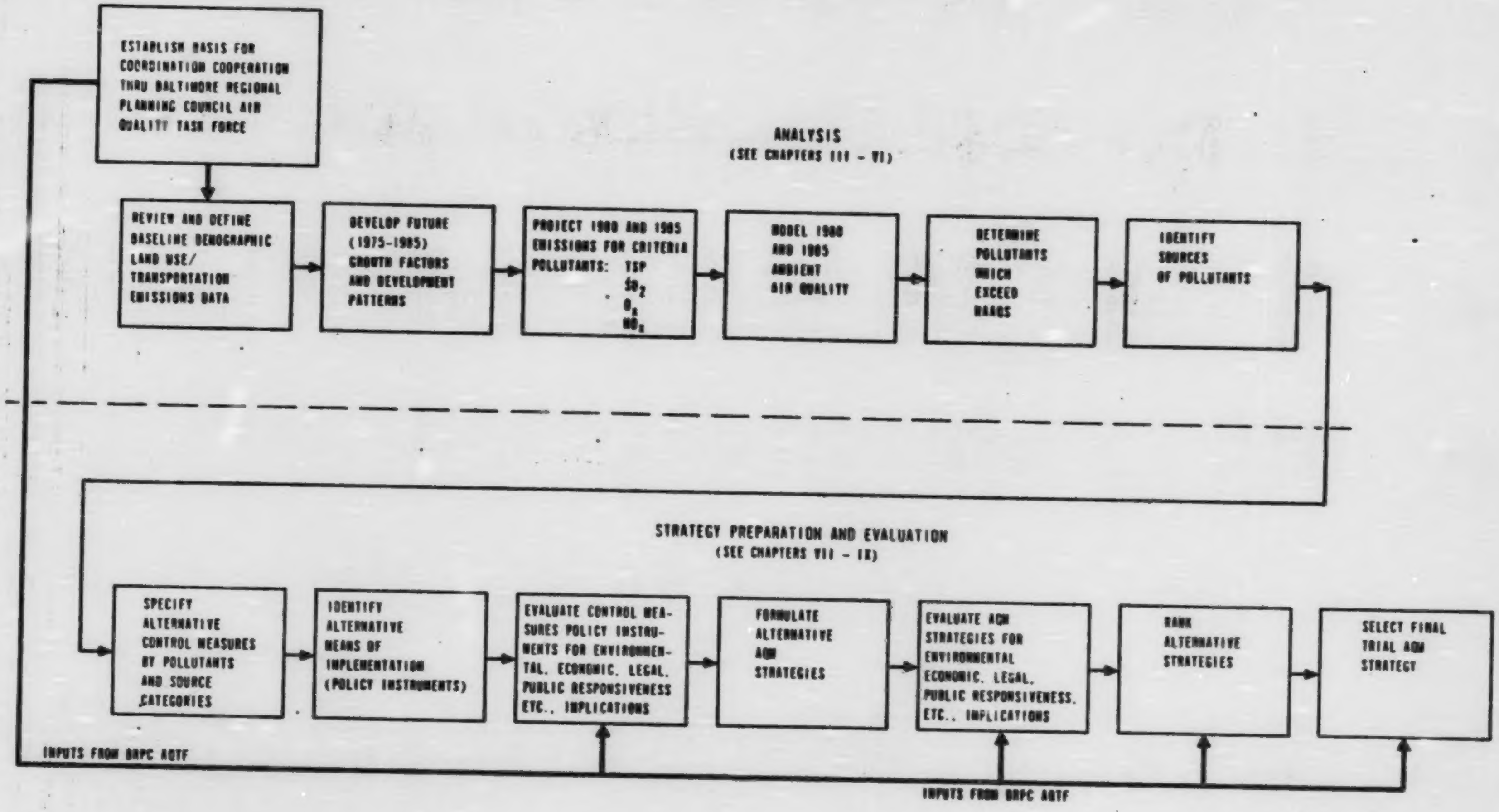
ESTABLISH BASIS FOR COORDINATION COOPERATION THRU BALTIMORE REGIONAL PLANNING COUNCIL AIR QUALITY TASK FORCE
ANALYSIS
(SEE CHAPTERS III - VI)
REVIEW AND DEFINE BASELINE DEMOGRAPHIC LAND USE/ TRANSPORTATION EMISSIONS DATA
DEVELOP FUTURE (1975-1985) GROWTH FACTORS AND DEVELOPMENT PATTERNS
PROJECT 1980 AND 1985 EMISSIONS FOR CRITERIA POLLUTANTS: TSP SO_2 O_x NO_x
MODEL 1980 AND 1985 AMBIENT AIR QUALITY
DETERMINE POLLUTANTS WHICH EXCEED NAAQS
IDENTIFY SOURCES OF POLLUTANTS
STRATEGY PREPARATION AND EVALUATION
(SEE CHAPTERS VII - IX)
SPECIFY ALTERNATIVE CONTROL MEASURES BY POLLUTANTS AND SOURCE CATEGORIES
IDENTIFY ALTERNATIVE MEANS OF IMPLEMENTATION (POLICY INSTRUMENTS)
EVALUATE CONTROL MEASURES POLICY INSTRUMENTS FOR ENVIRONMENTAL, ECONOMIC, LEGAL, PUBLIC RESPONSIVENESS ETC., IMPLICATIONS
FORMULATE ALTERNATIVE AQM STRATEGIES
EVALUATE AQM STRATEGIES FOR ENVIRONMENTAL ECONOMIC, LEGAL, PUBLIC RESPONSIVENESS, ETC., IMPLICATIONS
RANK ALTERNATIVE STRATEGIES
SELECT FINAL TRIAL AQM STRATEGY
INPUTS FROM BRPC AQTF
INPUTS FROM BRPC AQTF

Diagram 1
Baltimore AQM strategy
development process

(1) State

(a) Maryland Department of Health and Mental Hygiene, Bureau of Air Quality Control;

(b) Maryland Department of Transportation, Division of Systems Planning and Development;

(c) Maryland Department of State Planning, Office of Regional and Local Planning--Baltimore Area; Office of Comprehensive State Planning--Natural Resources.

(d) Office of Maryland State Attorney General.

(2) Regional

(a) Regional Planning Council
- A.95 Review
- HUD 701 Planning Programs
- 3C Planning Programs
- Land Use, Environmental and Community Development Section and Recreation Department
- Transportation Section
- Air Quality Task Force

(3) Local

(a) City of Baltimore
Mayor's Office*
Department of City Planning
City Health Department*
Interstate Division for Baltimore City (Joint City/State)

(b) Anne Arundel County
Department of Planning
Citizen Representative*

(c) Baltimore County
County Development Coordinator*
Department of Planning

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*Indicated that contacts were made primarily or solely through the Air Quality Task Force of Baltimore Regional Planning Council.

(d) Carroll County
Citizen Representative*
County Health Department*
Department of Planning

(e) Harford County
County Planning and Zoning Commission*

(f) Howard County
Department of Planning
Citizen Representative*

(g) City of Annapolis
Director, Planning and Development*

The pertinent established relationships between these agencies, and study groups such as the Baltimore Region Environmental Impact Study (BREIS), are indicated in Figure 3.

There were many concerned private interest groups identified in the metropolitan area. Among those identified and participating in the activities of the Regional Planning Council's (RPC) Air Quality Task Force were:

(1) Baltimore City Medical Society,

(2) Better Air Coalition,

(3) American Lung Association of Maryland,

(4) Baltimore Chamber of Commerce, and

(5) Baltimore Gas and Electric Company.

In at least one sense, the procedures used in preparation of this trial plan cannot be considered a fair test of the institutional procedures which should be followed in developing the final maintenance plan. This effort was EPA-initiated and contractor-performed with a requirement that the contractor establish the best coordination possible in the process of plan preparation. In the preparation of the final AQMP, the responsibility will generally

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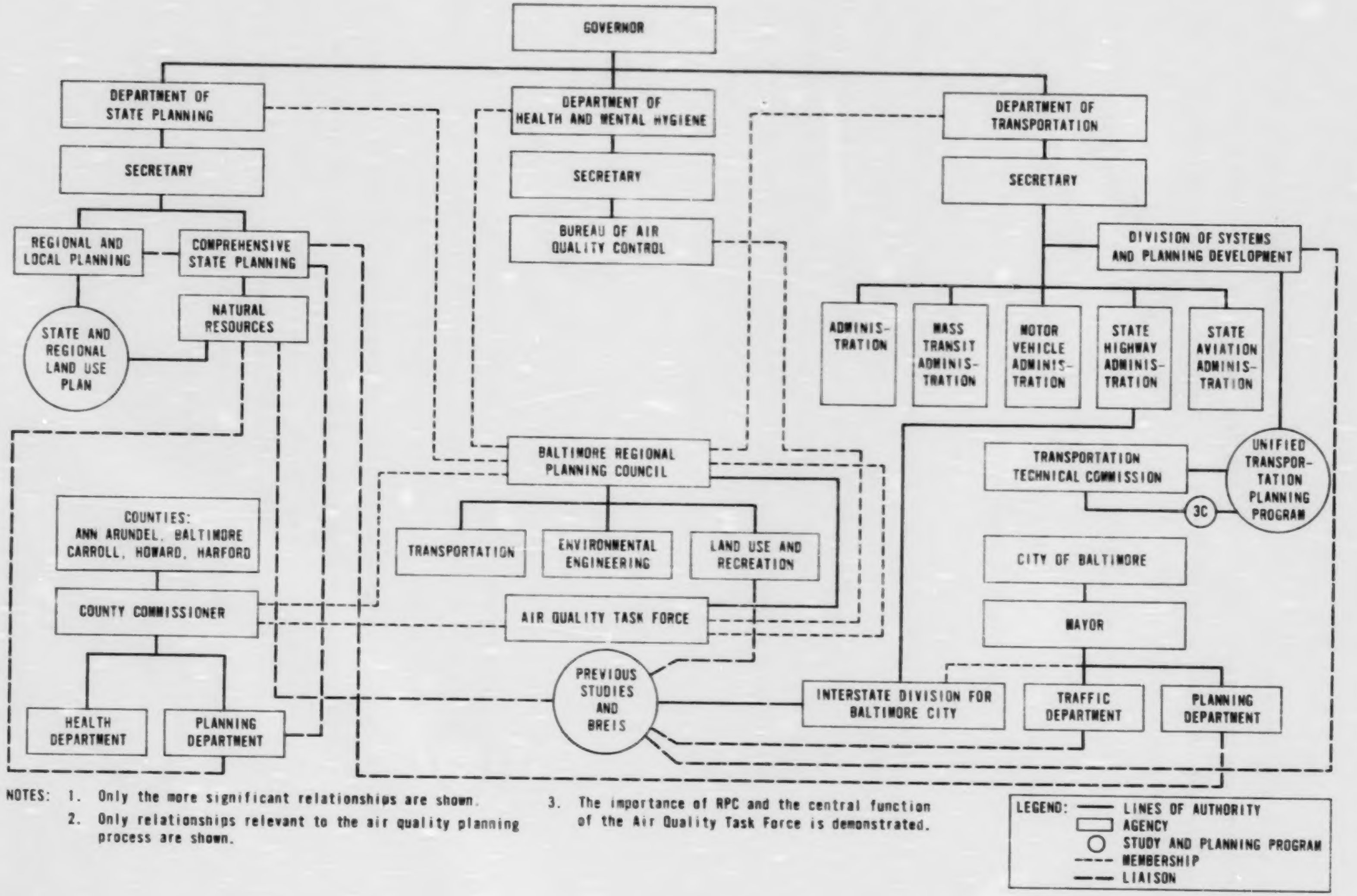
*Indicates that contacts were made primarily or solely through the Air Quality Task Force of Baltimore Regional Planning Council.


GOVERNOR
DEPARTMENT OF STATE PLANNING
SECRETARY
REGIONAL AND LOCAL PLANNING
COMPREHENSIVE STATE PLANNING
NATURAL RESOURCES
STATE AND REGIONAL LAND USE PLAN
DEPARTMENT OF HEALTH AND MENTAL HYGIENE
SECRETARY
BUREAU OF AIR QUALITY CONTROL
DEPARTMENT OF TRANSPORTATION
SECRETARY
DIVISION OF SYSTEMS AND PLANNING DEVELOPMENT
ADMINIS-TRATION
MASS TRANSIT ADMINIS-TRATION
MOTOR VEHICLE ADMINIS-TRATION
STATE HIGHWAY ADMINIS-TRATION
STATE AVIATION ADMINIS-TRATION
BALTIMORE REGIONAL PLANNING COUNCIL
TRANSPORTATION
ENVIRONMENTAL ENGINEERING
LAND USE AND RECREATION
AIR QUALITY TASK FORCE
COUNTIES: ANN ARUNDEL, BALTIMORE CARROLL, HOWARD, HARFORD
COUNTY COMMISSIONER
HEALTH DEPARTMENT
PLANNING DEPARTMENT
PREVIOUS STUDIES AND BREIS
TRANSPORTATION TECHNICAL COMMISSION
UNIFIED TRANSPOR-TATION PLANNING PROGRAM
3C
CITY OF BALTIMORE
MAYOR
INTERSTATE DIVISION FOR BALTIMORE CITY
TRAFFIC DEPARTMENT
PLANNING DEPARTMENT
LEGEND:
LINES OF AUTHORITY
AGENCY
STUDY AND PLANNING PROGRAM
MEMBERSHIP
LIAISON

NOTES:
1. Only the more significant relationships are shown.
2. Only relationships relevant to the air quality planning process are shown.
3. The importance of RPC and the central function of the Air Quality Task Force is demonstrated.

Figure 3. Existing institutional relationships - Baltimore air quality planning

lie with a state agency. Such an agency is part of the public institutional structure and has established working relationships with other agencies. It also has the status to establish additional relationships as may be necessary for successful completion of the plan.

Given the nine-month planning period which will be available to the states and metropolitan areas for completing their respective AQMA plans, the following changes might be made in the approach to ensure more detailed coordination with and involvement of agencies, elected officials, and the public:

(1) Stronger relationships should be established with the functional agencies involved. In the work resulting in this report, the more important agencies were contacted. Therefore, for future related activities, the list of agencies to be involved would probably not expand greatly; however, the frequency of communication and the degree to which agencies would be asked to provide data, advice, and assistance should be increased.

(2) The groups established to oversee or coordinate air studies or study programs (Unified Transportation Planning Program, State Land Use Plan, Regional Land Use Plan, BREIS) should be briefed on the study scope, methodology, and findings and asked to respond during the course of plan preparation. One purpose of this approach would be to further integrate air quality planning with comprehensive land use/transportation/economic/resource planning.

(3) The technique of working with a regionally oriented steering committee, study group, or task force is highly advantageous. The existence and cooperation of the Air Quality Task Force was invaluable during this study effort; however, in the actual AQMP development the group should, ideally, be more deeply involved. Changes which might be considered by the Air Quality Task Force are as follows:

(a) Expand its membership, especially from the city and the counties, to assure that all segments of the general public are adequately represented.

(b) Publicize its work and functions with the objective of obtaining greater attendance and heightened interest;

(c) Make it short-lived with the express function of guiding the development of the maintenance plan;

(d) Give members tasks and participation in the program; and

(e) Develop periodic working papers for review in committee discussion in the counties and to assist in obtaining community responses.

(4) Publicize the study and provide information to all interested parties. News media can be utilized, but a local telephone number from which either information can be obtained or to which questions can be referred for later reply can be an effective device.

(5) Near the conclusion of the study, after preparation of the draft report, a series of local "workshops" might be held in the Cities and the counties at which preliminary findings could be presented and community reactions recorded. Such workshops could be informal so as to not be confused with public hearings held after preparation of a proposed rulemaking.

REVIEW OF DATA BASE

An early important and necessary step in preparing the pilot Air Quality Maintenance Plan was to review several basic data files, including:

(1) Maryland State Implementation Plan (SIP),

(2) State, Regional, and Local Land Use/Transportation Plans, and

(3) Baltimore Regional Demographic Information.

Of prime importance in the SIP were the emission inventories, air quality data, and control strategies for the various contaminants. It was readily apparent that the emission inventory and air quality data sections found

Table 1. COMPARISON OF NATIONAL EMISSION DATA SYSTEM INFORMATION TO MARYLAND EMISSION INVENTORY INFORMATION FOR SIX PLANTS

Facility	Data system	Emissions--tons/year				
		PART.	SO_x	NO_x	HC	CO
American Smelting and Refining Baltimore City 22 point sources	NEDS[a]	2,056	1,818	964	30	316
	MEI[b]	174	572	538	23	350
Glidden Durkee Baltimore City 25 point sources	NEDS	306	2,934	2,864	108	2,000
	MEI	529	3,007	1,185	111	20,002
Cambridge Rubber Co. Carroll County 4 point sources	NEDS	6	48	28	110	0
	MEI	1	47	27	98	0
Springfield State Hospital Carroll County 5 point sources	NEDS	3,294	1,944	494	334	0
	MEI	101	557	350	15	0
Mobil Oil Baltimore City 1 point source	NEDS	0	0	0	1,300	0
	MEI	0	0	0	879	0
Shell Oil Baltimore City 1 point source	NEDS	0	0	0	1,598	0
	MEI	0	0	0	1,824	0

(a) From National Emission Data System-Maryland 1971 Emission Inventory

(b) From Maryland Air Quality Control Bureau-Maryland 1973 Emission Inventory in the SIP required updating to reflect current conditions and to provide a more sound base from which future projections would be made. Engineering-Science, Inc. obtained a copy of the Baltimore Region emission inventory from the National Emission Data System (NEDS). A second set of emission data was obtained from the Maryland Bureau of Air Quality Control. A comparison was made between the two data files for completeness, accuracy, and age. The Maryland Emission Inventory (MEI) was selected in preference to the NEDS data for several reasons. A comparison of several small, medium, and large sources listed in both systems revealed wide variations (Table 1). In addition, as shown in Tables 2 and 3, the MEI offered a more complete listing of point sources than did the NEDS print-out. Finally, the two data files were compared for general completeness. Carroll County facilities emitting in excess of 100 tons/year of pollutants were accessed from both systems. Ten such facilities were found in the MEI as compared with five in NEDS. Subsequent discussions with the staff of the Maryland Bureau of Air Quality Control revealed that the NEDS data files were being updated. It was, therefore, decided that the MEI data would be used for this study

Table 2. COMPARISON OF FEDERAL NEDS INFORMATION TO MARYLAND EMISSION INVENTORY FOR POINT SOURCES AT ONE FACILITY[(a)]

Data system	Emission point	Emissions -- tons/year				
		PART.	SO_x	NO_x	HC	CO
NEDS	1	1	4	2	0	0
	2	1	4	2	0	0
	3	0	6	0	298	0
MEI	1	.36	1	1.5	0	0
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	0	0	0	298	0

(a) Plant--Standard Brands
County--Baltimore City

Table 3. COMPARISON OF FEDERAL NEDS INFORMATION TO MARYLAND EMISSION INVENTORY FOR POINT SOURCES AT ONE FACILITY[a]

Data system	Emission point	Emissions -- tons/year				
		PART.	SO_x	NO_x	HC	CO
NEDS	1	338	2,220	871	16	7
	2	338	2,220	871	16	7
	3	467	4,080	1,320	24	32
MEI	1	6	35	78	1	0
	2	48	930	780	15	0
	3	42	805	671	13	0
	4	66	1,280	1,009	19	0
	5	42	805	671	13	0
	6	38	120	390	12	0

(a) Plant--Baltimore Gas and Electric--Westport
County--Baltimore City

effort. It is suggested that, when the final AQMP is developed, the updated NEDS file be reviewed and, if found in satisfactory order, used as the official data base for current and projected emissions because the NEDS system contains several emission parameters useful in diffusion modeling which are not found in the present MEI file.

For air quality data, data found in the SIP, together with more recent particulate and oxidant data from the Maryland Bureau of Air Quality Control, were utilized. These data were used for calibration of the Air Quality Display Model in the case of particulates and for direct input into the roll back/roll forward model to calculate oxidant levels.

Early in the study ES considered the necessity to develop an AQMP to meet the Maryland State Air Quality Standards as presented in the SIP. Table 4 compares these Federal and State standards and clearly indicates the State standards to be more stringent in many cases. Federal standards were selected for the purpose of designing this pilot maintenance plan.

There is a fundamental relationship between air quality and the magnitude and distribution of a region's population and economic activities. For this reason it was necessary to review the Baltimore Region's land use and transportation plans. These plans contained the basic data necessary for future growth projections of residential or employment centers, highway and mass transit availability or usage, etc. Several sources for this type of data existed in the Baltimore region and each is discussed briefly in the following paragraphs.

Data Sources

Regional Planning Council - As a major part of the Regional Planning Council's (RPC) development of a comprehensive plan for the Baltimore Region and of various other planning in the area, a comprehensive set of data and projections covering social and economic factors in the region had been developed. Based on the division of the six county regions into 94 Regional Planning Districts, the RPC had analyzed and reported on these characteristics of the region using 1960 and 1970 Census information as a source. These data had been compiled and reported in several documents published by the Council. Population and employment projections by District for 1980 and 1995 had also

Table 4. COMPARISON OF EPA AND MARYLAND AMBIENT AIR QUALITY STANDARDS

	National		State	
	Primary	Secondary	Serious	More adverse
Sulfur oxides				
Annual arithmetic mean, $\mu g/m^3$	80	-	79	39
24-hour maximum(b), $\mu g/m^3$	365	-	262	131
3-hour maximum(b), $\mu g/m^3$	-	1,300	-	-
1-hour maximum(c), $\mu g/m^3$	-	-	525	262
Particulate matter				
Suspended				
Annual mean, $\mu g/m^3$	75(a)	60(a)	75(d)	65(d)
24-hour maximum(b), $\mu g/m^3$	260	150	160	140
Settleable				
Annual arithmetic average, (mg/cm^2/month)	-	-	0.5	0.35
Monthly maximum (mg/cm^2/month)	-	-	1.0	0.70
Nitrogen dioxide				
Annual arithmetic mean, $\mu g/m^3$	100	100	100	100
Photochemical oxidants				
1-hour maximum(b), $\mu g/m^3$	160	160	160	160

(a) - annual geometric mean
(b) - not to be exceeded more than once per year
(c) - not to be exceeded more than 8 times per month in the Baltimore AQCR Area III
(d) - annual arithmetic mean

been made using a Lowry-Gravity type land use model. In its application here, after manually allocating major employers to the various planning districts, based on existing conditions and expectations for the future, population and service employment of various types were allocated to the various districts based on the desirability of each in terms of accessibility to major employment and other less tangible factors.

Maryland Department of Transportation - In response to litigation seeking to stop the construction of the 3A system of interstate highways, the Interstate Division for Baltimore City (IDBC), a division of the Maryland Department of Transportation (MDOT), undertook an environmental impact analysis of this system. As part of the process by which the Baltimore Region Environmental Impact Study (BREIS) was to be accomplished, a significant effort in the area of traffic modeling was undertaken. Models for trip generation, mode choice, and traffic assignment were constructed and run based on the results of the RPC land use model forecasts for eight alternative future transportation system conditions. Included were the 3A system, as well as several states of completion of that system for 1980 and 1995. Data on total Vehicle Miles Travelled for each Regional Planning District, stratified by type of highway and by level of congestion, were partial outputs of the BREIS models.

Bureau of Air Quality Control - In order to determine the effect of various transportation policies and individual projects on air quality in the Baltimore Region, the Bureau of Air Quality Control developed a methodology to predict Vehicle Miles Travelled. As a result of source methodological problems with application of speed correction factors to link specific average speeds, it was decided that the use of the conventional Baltimore Regional Planning traffic modeling package would be too complex and time consuming. Thus, that portion of the Koppelman Highway Needs model which related Vehicle Miles Travelled to the amount of highway in each district and to travel demand was applied. The region was divided into six districts and the model calibrated on existing travel data from the Baltimore Metropolitan Area Transportation Study (BMATS). Corrections to this calibration were made based on 1970 Census data and this result was used as the base year. Projections were made for various transportation system and policy alternatives using RPC data for population and employment projections on which to base trip generation (travel demand) and Maryland Department of Transportation plans for the amount of highways in the future.

Regional, Local Land Use and Transportation Plans

Although the emphasis in this study was on the regional development plan, because it contained the type of information necessary to predict growth on a regional level, a review was also made of local plans to gain a perspective of local development objectives and of the types of maintenance strategies that might be acceptable at the local level. The land use plans reviewed are briefly described below.

The Baltimore Region General Development Plan - The regional comprehensive plan for the Baltimore area, the General Development Plan (GDP), was adopted by the member jurisdictions of the Regional Planning Council in late 1972. Member jurisdictions include Baltimore City and Anne Arundel, Baltimore, Carroll, Harford, and Howard Counties. The Plan looks ahead twenty years and projects total regional population and employment growth as well as demographic changes by smaller subareas (regional planning districts). Reflecting the nine major goals adopted by the RPC in 1970, the GDP discusses the following planning elements: the natural and manmade environment, open space, water and sewer, transportation and energy, housing, and social services. Each of these elements is considered in the regional context and contributes to the regional development pattern and implementation proposed in the GDP.

The total population increase expected during the 1970-1990 planning period is 700,000 for a regional population of approximately 2,800,000. While this projected growth represents a significant rate of increase of more than 35 percent, it is considerably below earlier 1967 projections as indicated by 1970 Census data. Baltimore City is expected to retain most of its present 900,000 population through 1990; however, this will represent 30 percent of the regional total in 1990 in comparison to 45 percent in 1970. The suburban areas are expected to absorb approximately two-thirds of the population increase. Consequently, the GDP anticipates significant growth which will reside primarily in suburban locations.

It is interesting that the growth in the Metropolitan Washington area will contribute substantially to the growth forecast in the Baltimore region. Nearby Metropolitan Washington's population is expected to expand even further and, given the proximity of the Baltimore region, the decentralization of Federal employment, the location of Columbia and other attractive factors, Washington is expected to contribute almost one-third of the region's growth by 1990.

Projections for employment complement the population increase forecast for 1990. An increase of 300,000 through the planning period would achieve a regional employment total above 1,200,000. Typical of nationwide trends, the region's economic activities will gradually shift from goods producing towards services. Metrocenter (downtown Baltimore) will continue to be of primary economic importance to the region and the focus of new investment and employment. Elsewhere in the region, existing employment centers and new centers will offer major concentrations of employment. In summary the general plan asserts the continuation of metrocenter as the central core of economic life, as well as the increasing strengths of decentralized employment centers.

The transportation planning element clearly influences the actual distribution of new population and jobs in the region. The plan calls for "an integrated, balanced transportation system." As interpreted in the GDP, this means completion of new facilities and improvements to existing facilities for both highways and public transportation. Furthermore, the transportation plan is viewed as a means for assisting "the direction, timing, and extent of urban growth in conformance with both development policies and utility planning."

The regional development plan affords a guide to local jurisdictions which ultimately direct the characteristics of development in their collective decisions and use of land development controls. Essentially, the plan calls for concentrated development in metrocenter enhanced by the rail rapid transit and the 3A highway system, and corridor development chiefly related to the Washington-Baltimore attraction (between the Baltimore-Washington Parkway and U.S. 29), development along the Anne Arundel Freeway (Md. 2) to Annapolis, the industrial corridor toward Havre de Grace, corridor development along I-83 north of Towson, and to the Northwest

Freeway. Open space focused on stream valleys and large reserves of semi-rural and rural land use further define the corridor characteristics.

Anne Arundel County - The Anne Arundel County General Development Plan was prepared in the mid-1960's and adopted in 1967. The plan recognized the certainty of rapid growth contributed by employment opportunities in both Washington and Baltimore.

Baltimore City - Within the General Development Plan, a minority report from Baltimore City officials emphasized the specific development strengths which the city possesses. Reflecting many of the same concerns, the individual elements of the Comprehensive Plan (1970) addressed ways in which the city could revitalize residential development possibilities within the region's center, attract new population and jobs and strive toward solution of inner city problems.

Baltimore County - The 1980 Guideplan, the official master plan for Baltimore County, was adopted in 1972. Similar to other jurisdictions experiencing rapid growth, the Guideplan expressed concern for the "haphazard, ever-increasing conversion of the rural environment to urban use."

Carroll County - The Master Plan for Carroll County, amended through September 1973, suggests continued agricultural use throughout the county with principal development located in Westminster.

Harford County - The proposed revisions to the 1966 Harland Bartholomew plan address the following concerns:

(1) Limitation and phasing of residential development,

(2) Preservation of prime agricultural land and woodland, and

(3) Separation of communities and provision of central focus points.

Concern for air quality improvement is shown in the proposed policy to meet air pollution standards. Proposed policies which indirectly relate to air quality include the restriction of sprawl development, the location of higher densities near commercial and employment centers with good accessibility, clustering industrial and commercial activities, and promoting multi-purpose centers. Again, provision of public services, chiefly water and sewer facilities, is suggested as a means for development phasing or staging and curtailing development in agricultural lands.

Howard County - The General Plan for Howard County was adopted in late 1971. The plan forecasted further major employment attracted to the Baltimore-Washington corridor for a variety of reasons.

Data Source Selection

Choice of a data source for use in this study was based on the applicability of each source to air quality modeling and on the assumptions underlying each source. To determine air quality, changes in regional population, employment, and amount of travel (VMT) were required. Population and employment data forecasts for 1980 and 1995 stratified by small areas (RPD) were available only from the Regional Planning Council. Amount of travel (VMT) data were available from MDOT and BAQC. Several reasons existed for the choice of the MDOT data. First, these data were stratified by RPD while the BAQC data were stratified only into six super-districts. Second, the MDOT analyses were performed by using more complete travel simulation models. Finally, the MDOT data were available for the exact assumptions needed for this study base data (i.e., the General Development Plan highway and transit systems and no controls or policy changes in effect). While these two data sources were readily available, certain modifications such as assuming a certain number of persons per household were necessary in order to prepare the data for use in the modeling of air quality.

Baltimore Regional Population Growth

The six jurisdiction region is expected to attain a total population of 2,800,000 by 1990 of which an increasing proportion will be distributed in suburban locations principally along major highway and rail rapid transit corridors. The following discussion further details the proposed allocation of population as represented in the GDP and the data requirements which are important to AQMA analysis and AQMP measures.

The GDP estimates that a total of 100,000 acres will be needed to accommodate the development requirements of 700,000 new residents and 300,000 new jobs in the region. Of this amount, 64,000 acres of land are calculated for residential use; 49,000 acres would be single-family development and 15,000 acres would be multi-family development. It is estimated that over 85 percent of the new land for residential purposes will be developed in

Anne Arundel, Baltimore, and Howard Counties. The new town of Columbia alone will accommodate 10 percent of the regional increase or approximately 70,000 persons during the planning period.

Information necessary for air quality analysis includes population totals and densities by small area. These data can be provided for the Baltimore region by Regional Planning Districts (RPD's). Transportation planning efforts have generated subarea totals, residential acreages, and number of dwelling units. From these forecast data, residential densities can be determined.

Suburban growth such as this has often meant spread development. However, as proposed by the regional plan, the actual location of new population is to be controlled by the provision of a wide range of public facilities, most notable of which are sewers, highways, and mass transit lines. In addition, continuation of growth in the new town of Columbia is encouraged as well as is the location of residents close to major employment centers. The following areas are expected to experience significant urban expansion:

(1) The Baltimore-Washington corridor, as defined by the four principal highways linking the two metropolitan centers. Baltimore-Washington International (BWI) Airport and Columbia are located within this corridor.

(2) Route 2 development focused at Glen Burnie and Annapolis.

(3) I-95 industrial corridor development toward Aberdeen and Havre de Grace.

(4) Expansion of Towson government employment center.

(5) Growth focused at Ownings Mills along U.S. 40 and the Northwest Freeway.

(6) Social Security employment center at the intersection of the Beltway and I-70N.

The areas of expansion are contained within transportation corridors shaped by open space. Densities at major employment areas or multipurpose centers are keyed to mass transit availability in every instance cited above.

Consequently, in terms of air quality data associated with population and urban expansion, all pertinent information is available as to densities of residential development and proximity to highway arterials or rapid transit.

Of the 300,000 new jobs estimated by 1995, about one-third will locate within four RPD's most closely associated with metrocenter. The GDP states that Metrocenter "will be a prime focus of new investment and employment." However, manufacturing and wholesale trade is expected to decline in importance and this will be noticeable in metrocenter and adjacent areas ringing the harbor. The principal sites for other employment growth within the city will be institutions such as universities and medical centers.

Major existing employment areas will receive one-half of the new employment. Columbia, Maryland will have a dramatic increase in employment of approximately 36,000 jobs as General Electric becomes a major employer. Other major employment centers include Social Security, Towson, Fort Meade, and Port industrial plants. Elsewhere, suburban employment growth is projected in the south and southwest industrial area, BWI Airport and Glen Burnie.

Planning data available on employment include forecast employment totals and type by RPD. This information adequately addresses the two issues concerned with air quality, namely distribution of employment relative to work-trip VMT and distribution of industrial point sources.

ANALYSES OF PROJECTIONS

The true need for an air quality maintenance plan is a direct function of expected growth of population and employment in a given region. The Regional Planning Council and OBERS projections were used to forecast the growth rate for the Baltimore Metropolitan Area.

According to the Regional Planning Council, the increase in population from 1970 to 1990 was estimated to be 35 percent (from 2.07 million to 2.80 million), an annual rate of just over 1.5 percent. Most of this growth was expected to occur in the outer suburban counties with Howard County increasing by 226 percent to 226,000, Harford County by 67 percent to 192,000, Carroll County by 63 percent to 113,000, and Anne Arundel County by 78 percent to 529,000. The already highly populated areas of Baltimore City and County were expected to experience smaller changes with the County increasing 39 percent to 862,000 and the City declining 3 percent to 878,000. Therefore, by 1990 the City would be expected to have only 32 percent of the region's total population as contrasted with 44 percent in 1970.

Similarly, substantial growth in employment was forecast by RPC and OBERS. The former agency predicted an increase from 869,000 to 1,180,000 in the period 1970 to 1990, a change of 36 percent. OBERS projected an increase to 1,090,000 by 1990, a value only 7.6 percent different from the RPC forecast. Each forecast predicted a shift in the proportion of total employment accounted for by various major industry types. In general, more service, government, financial, wholesale, and retail trade employment would occur while the proportion in transportation and utilities, manufacturing and mining, and agriculture would decline.

Data for 1970, 1980, and 1995 were taken from tabulations of actual data and simulation results provided by the Baltimore Regional Planning Council. Data for 1973, 1977, and 1985 were interpolated assuming linear growth. Because data were not available for number of dwelling units, certain assumptions were made on household size. These assumptions reflected a downward trend in the factor, resulting in more dwelling units per population in the later stages of the period under study (Table 5).

Table 5. PROJECTIONS OF HOUSEHOLD SIZE

RPD Code No's	Jurisdiction	1970	1973	1977	1980	1985	1995
100	Baltimore City	3.06	2.81	2.69	2.60	2.54	2.51
200	Anne Arundel	3.45	3.17	3.04	2.93	2.86	2.83
300	Baltimore Co.	3.28	3.02	2.89	2.79	2.72	2.69
600	Howard Co.	3.59	3.31	3.16	3.05	2.98	2.94

The 1970 figures used represent actual data as reported in the 1970 Census of Population. The Baltimore Regional Planning Council reported that household size had declined 10 percent in the period 1968-1974 and that much of this decline had occurred since 1970. Hence, the 1973 figures represented an 8 percent drop since 1970. By 1980, this trend was assumed to have continued but at a decreasing rate. Thus, the 1977 figures were predicted 12 percent below those of 1970 and the 1980 figures were predicted 15 percent below those of 1970. The trend was assumed to continue but at an almost negligible rate from 1980 onward. Therefore, 1985 figures were 17 percent below 1970 and 1995 figures were 18 percent below 1970. Regionwide, the average household size by 1995 was thus approximately 2.7 persons per household.

As discussed in an earlier section, the data available from the MDOT BREIS report was utilized in this analysis. The data available from MDOT was VMT by RPD stratified by functional classification and by level of service. Because calculations of average speed were not available, certain assumptions were made and calculations prepared to arrive at these values. For each level of service and each functional class, the following speeds were assumed (mph):

Level of Service	Freeway	Major Arterials	Minor Arterials	Local Strip	Ramps
A	60	40	30	20	40
B	55	30	25	20	30
C	50	20	20	15	20
D	40	15	15	15	15
E	30	10	10	10	10
F	20	3	5	5	5

These values were based on the definitions of level of service in the Highway Capacity Manual, 1965. The average speed was then calculated, weighted by the amount of VMT occurring in each function--level of service class. This value then represented the average speed on the links contained within the network.

To calculate the VMT by vehicle class, the VMT's were factored by 1.012 to reflect intrazonal trips not occurring on the network and by 0.888 to reflect the fact that, while 18 percent of average daily traffic occurs in the afternoon peak for which these data were calculated, only 16 percent of daily traffic occurs in the morning peak. Thus, despite the fact that the afternoon peak period (3:30 to 5:30 p.m.) is only two hours long while the morning peak is three hours (6:00 to 9:00 a.m.) in length, less traffic occurs in the morning peak period.

Based on a communication with MDOT, factors of 15 percent of peak hour travel for Medium Duty Vehicles (MDV) and 1.5 percent for Heavy Duty Vehicles (HDV) were applied. MDV's were defined as light trucks (those with two axles) while HDV's were defined as heavy trucks (with more than two axles). Although this does not totally agree with EPA's definition, the calculated resulting emissions were correctly categorized.

Because simulations were available for 1970, 1980, and 1995, the 1973, 1977, and 1985 data were interpolated linearly. Where travel in a certain district increased substantially from 1970 to 1980, accompanied by a similar increase in speed, an examination was made of new freeway links in the area because great increases in volume and speed could only occur in new roadways. If no new links had been added by 1973, the average speed in 1970 was assumed to remain the same until 1973. In these cases, 1977 values were interpolated between 1973 and 1980 average speeds.

Because of the large changes in the system which will occur between 1980 and 1995, the values obtained for 1985 linear interpolation could be improved with more sophisticated techniques. Because the transportation system assumed for 1980 included only two of the full six-legged system assumed for 1995, the level of transit ridership in 1985 would be sensitive to factors such as the phasing of network construction not reflected in a linear interpolation. Also not reflected is the decreasing rate of increased auto ownership forecast for the period 1980-1985. Further, trip length increases in the period would likely not occur linearly. Thus, while the linear interpolation performed in order to achieve values for 1985 was the best technique possible given the resources available, results taking into account all of the factors governing travel in 1985 would require the utilization of modeling techniques such as the transportation model used in the BREIS analysis for 1970, 1980, and 1995.

In general, there were few areas in Baltimore where the data available in the region did not meet the needs of this study. Data on VMT by Regional Planning District were readily available from the MDOT BREIS project. Because data were not available for the study years 1977, 1980, and 1985 and for the a.m. peak hours, certain interpolation and manipulation techniques were applied to the data base. However, given sufficient time and resources, a run of the BREIS models could have been performed to provide these data in the required formats and time scale. Further, more accurate calculations of average speed could have been made using the speeds resulting from the actual assignment of traffic to the various sections of the road network, rather than by using the manual procedure discussed.

To account for those RPD's outside the present cordon line (see Figure B-1, Appendix B) it would be necessary to extend the cordon line to the limits of the AQMA. This could be done in two ways. A more precise method would be to expand the traffic model to include the appropriate links in all those RPD's currently outside the cordon. However, this would be expensive and would likely require more time than is available under the proposed AQMP guideline.

A second, more approximate approach, would be to use existing employment, population, highway network, and traffic data in the RPD's not presently included. These data would be used to generate a set of approximate relationships to bring out the following information:

(1) Trips from outside the AQMA cordon,

(2) Trips from the added RPD's which cross the present cordon line,

(3) Trips between the added RPD's, and

(4) Trips within each of the added RPD's.

Considering that the population and employment data available in these RPD's are consistent with overall regional data, there exists a basis for estimating the trip data listed above. A test of these relationships would have to be made and could, perhaps, be based on existing traffic counts at the AQMA boundary or within the added RPD's.

Demographic data were readily available from the RPC for most of the planning districts. However, the RPC did not maintain data files for many of the districts outside the Baltimore Metropolitan Area. Other growth factors were assumed in these instances with the intent of expediting the study but with the full understanding that the assumptions could be in error, especially in those areas slated for development.

Where RPC data were lacking, county growth factors may provide information for more refined assumptions. In addition, the possibility of obtaining employment projections from commercial and industrial organizations should be explored. A second approach would be to investigate the availability of state projections which could be adjusted to a county level, based on historical trends. The use of trend analysis involves introducing potential errors. If a county has historically grown slowly but is on the edge of a rapidly expanding urban area, its future growth may be much greater than historical trends would indicate. Conversely, if a county has experienced recent rapid growth, then growth may tend to taper off in the future, particularly if land-use plans or sewer moratoria constrain growth. Local information is required to refine the results of simple trend analyses to account for these factors.

Even with perfect projections of those selected emission indicators, the problem of relating indicators to emissions is still difficult. Identifiable sources are, for the most part, stringently controlled. As these sources are controlled, the residual emissions, whether true background or anthropogenic in character, become more and more important. For instance, in the case of suspended particulates in the BMAQMA, the background concentration is near 40 $\mu g/m^3$. At least some of this background is surely due to man's general activity and would be expected to grow as man's activities grow. The tendency would be not so much for background levels to increase in city centers but for high levels of background concentration to encompass larger areas.

In the case of particulates and SO_2, a tool exists in the form of dispersion modeling to at least estimate the unaccounted for emissions even if their spatial distribution is unknown. Such is not the case for oxidants and NO_2 where methods to estimate precursor residual emissions are not available. If these are, in fact, a large part of total emissions the roll back effect on air quality will be severly diluted.

It is hoped that all of the above points emphasize the necessity for the most accurate and complete baseline year emission inventory along with concurrent air quality measurements. Complete instructions will be available for projecting emissions in the EPA guideline manuals. In the study reported herein, those instructions were not followed specifically because of their non-availability and time constraints. It is interesting to note, however, that independently the same growth indicators were selected as were recommended in the manual.

CHAPTER III

PROJECTED AIR QUALITY ANALYSES: PARTICULATES

AIR QUALITY

The Maryland Bureau of Air Quality adopted particulate standards to promote the general health and welfare for all its citizens. The Maryland ambient air quality standards in some cases are more stringent than the National Ambient Air Quality Standards as shown below:

Averaging Time	Maryland Serious	 More adverse	Secondary NAAQS
Annual mean, $\mu g/m^3$	75 (a)	65 (a)	60 (b)
24-hour maximum, $\mu g/m^3$	160	140	150

(a) arithmetic mean (b) geometric mean

Air quality levels for particulates generally exceeded both the Maryland and NAAQS with the highest concentrations being recorded in the industrial zones and in the downtown Baltimore urban area (Table 6). Rural background levels averaged around 40 $\mu g/m^3$ compared to the standard of 60 $\mu g/m^3$. Hot-spots of particulates are currently observed in the vicinity of the steel mill but as compliance schedules are met the overall maximum ground level concentration is expected to shift toward the center of the urbanized area. The 1973 air quality monitoring stations are shown in Figure 4 along with isopleths of measured concentrations. The Fire Station No. 10 station results appear to be inconsistent with readings of all other city stations and should be seriously questioned. The station reportedly is close to several unpaved driveways, truck terminals, and streets without curbs and gutters and these may be the source of the abnormally high readings.

BASELINE EMISSION INVENTORY

A magnetic tape of the Maryland emission inventory was obtained from the Bureau of Air Quality Control. The computer tape listing provided easy access to the multitudinous emission data and allowed the selection of those data which were important in making projections with the air quality display model (AQDM). The magnetic tape was developed from the Maryland

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Table 6. BALTIMORE AQMA PARTICULATE CONCENTRATIONS ($\mu g/m^3$)

Station location	Site code	Quarterly Average 1	2	3	4	AAM	24-hour Max.	2nd
Anne Arundel County								
Glen Burnie	210080003	64	75	97	71	77	197	172
Harmons	210080006	51	80	76	51	65	154	151
Harwood	210080008	26	40	47	42	38	115	101
Linthicum	210080001	71	88	71	60	73	178	176
Odenton	210080002	35	56	70	47	53	149	120
Riviera Beach	211360002	50	52	70	53	56	117	106
St. Johns	210060002	46	60	74	64	60	145	128
Baltimore County								
Catonsville	210140004	36	52	50	57	49	144	116
Cockeyesville	210500001	29	48	102	72	63	345	313
Essex	210680001	57	83	98	82	80	182	174
Garrison	210140003	64	83	90	67	76	255	179
Lansdowne	211040001	64	76	77	67	71	149	137
Solless Point	210620001	67	81	85	84	79	180	167
Middle River	210120021	52	57	86	70	66	151	151
Towson	211640001	43	50	59	65	54	185	154
Baltimore City								
Fire Department Hdq.	210120001	92	112	79	104	99	351	328
Fire Department # 10	210120005	145	157	147	142	148	413	404
Johns Hopkins	210120014	67	62	84	77	73	130	122
Morgan	210120015	51	51	62	57	55	102	90
NW Police Station	210120007	103	69	66	58	74	285	179
NE Police Station	210120006	81	60	58	49	62	276	237
SE Police Station	210120008	105	105	92	93	99	306	271
SW Police Station	210120009	104	82	70	77	83	395	305
Poly	210120016	64	64	67	62	64	208	162
State Office Building	210120003	65	104	76	-	82	415	182
Carroll County								
Westminster	211720002	33	45	109	40	57	109	89
Harford County								
Bel Air	210180001	47	55	67	55	56	135	116
Whiteford	210920002	30	43	58	42	53	126	103
Howard County								
Simpsonville	210960003	37	54	68	53	53	135	121

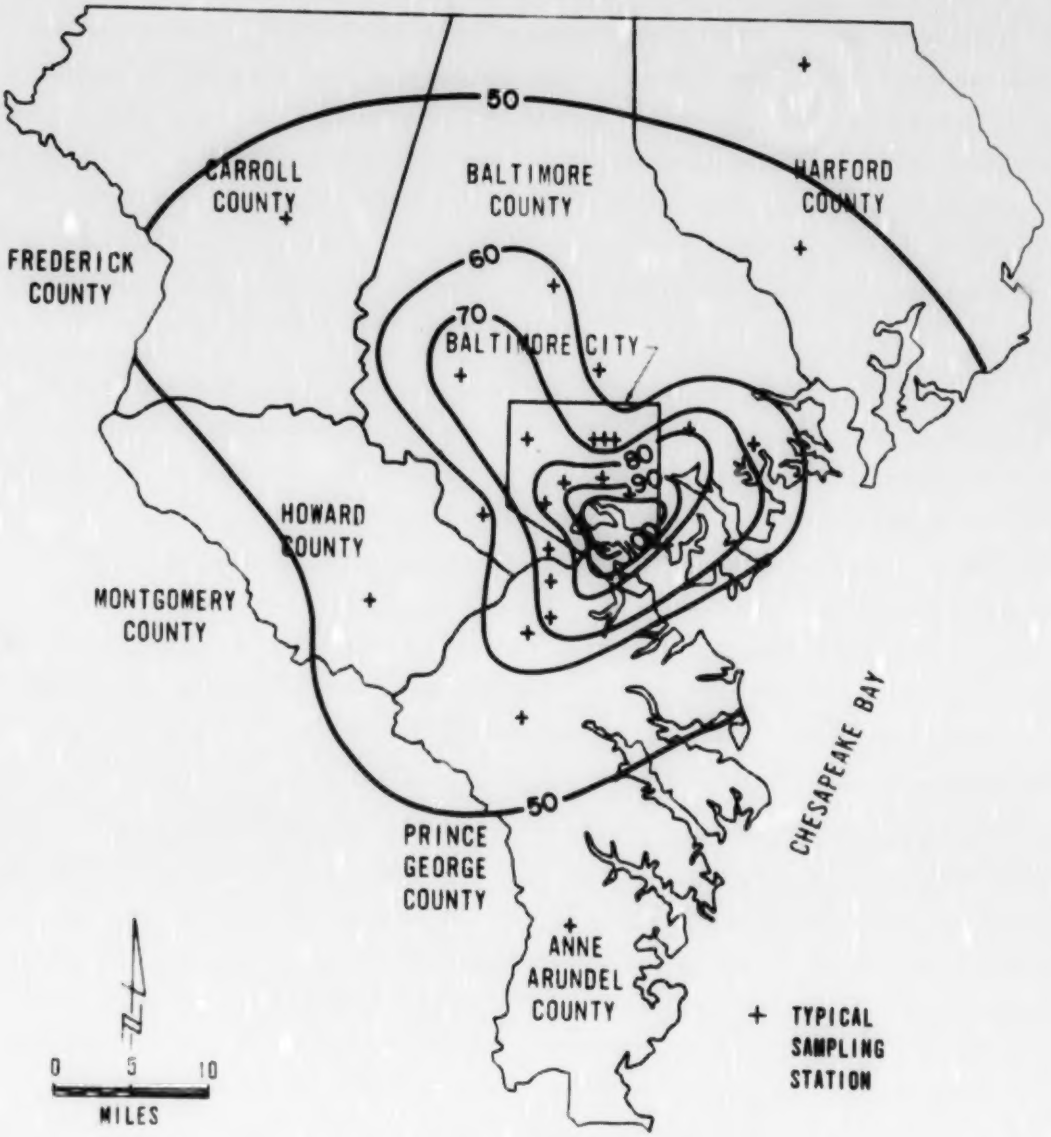
50
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
60
70
BALTIMORE CITY
80
90
100
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
50
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
+ TYPICAL SAMPLING STATION
N
0 5 10
MILES

Figure 4. Observed annual average particulate concentration (ug/m^3) 1973

air pollution permit system and included over 20,000 individual point and area sources. The lower cut-off limit of sources included in the inventory file was one pound per day of any pollutant. The tape was updated in December 1973 and thus represented the most current information on emissions in the State of Maryland. While some of the area source entries still carried the 1970 original entry date, the majority of sources had been reviewed periodically and updated to reflect current emissions, installation of abatement equipment, and new processes for point sources.

During this investigation, no attempt was made to verify emissions from any of the point sources. However, area source emissions (mobile, home heating, etc.) were confirmed to be essentially correct as determined from traffic density and home heating requirements expected for the Baltimore area. Area sources were separated into several categories. These included emissions generated from cars, trucks, home heating units, small commercial facilities, and "other" sources. Projections of impacts on air quality were made for each of these individual categories with the exception of "other" sources. (Neither growth nor reduction in the "other" source category was assumed for the projection period.)

A computer program was prepared to summarize certain portions of emission data from the computer tape which would be relevant to modeling. The data included the x and y coordinates of each point source and emission rates for particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons and other pollutants. For area sources, grid location was extracted along with emission rates. Table 7 illustrates the type of computer printout report that was prepared as a first step in summarizing emissions from the five county (plus Baltimore city) area. Table 7 is one of approximately 500 output pages which were printed to provide a complete listing of every point and area source within the SMSA. "County = 3" in the heading of Table 7 refers to the code for Baltimore County. The table also shows the name and/or location of the source ("Premise ID") and an indication of the source type (Premise code "1" is for process losses, "2" is for fuel combustion, and "3" is for incineration). The horizontal and vertical coordinates are also listed in the table (hor and ver). The year in which the source was registered (reg) and installed, the stack height code, the grid location and emission rates were also included on the Maryland tape and summarized as shown in Table 7.

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Table 7.

MARYLAND EMISSION INVENTORY
COUNTY = 3

PREMISE ID	PREMIS CODE	NO	CORDINAT HOR	CORDINAT VER	YEARS RES	YEARS IN	STAK	GRID LOCA	EMISSION RATE (LB/AVG. DAY) SO2	PART	NOX	CO	HC	OTHER
ROGERS FORGE RD. 240	2	19	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
ROGERS FORGE RD. 230	2	20	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
ROGERS FORGE RD. 233	2	21	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
ROGERS FORGE RD. 239	2	22	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
ROGERS FORGE RD. 227	2	23	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
ROGERS FORGE RD. 207	2	24	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
ROGERS FORGE RD. 201	2	25	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
BLENHEIM RD. 6627	2	26	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
BLENHEIM RD. 6617	2	27	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
BLENHEIM RD. 6603	2	28	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
BLENHEIM RD. 6610	2	29	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
DUMBARTON RD. 107	2	30	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
DUMBARTON RD. 105	2	31	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
DUMBARTON RD. 120	2	32	907	562	70	69	2	37	0.0	0.0	1.0	0.0	0.0	0.0
DUMBARTON RD. 117	2	33	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
DUMBARTON RD. 125	2	34	907	562	70	69	2	39	0.0	0.0	1.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	2	35	959	554	69	65	2	40	2.0	1.0	6.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	2	35	959	558	69	64	1	40	2.0	1.0	6.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	2	35	959	558	69	00	1	40	2.0	1.0	4.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	73	00	2	40	0.0	0.0	0.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	71	71	3	40	12.0	22.0	16.0	0.0	1.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	69	63	3	40	32.0	39.0	18.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	69	62	1	40	4.0	0.0	16.0	0.0	0.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	70	00	3	40	110.0	48.0	63.0	2.0	2.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	70	55	3	40	34.0	310.0	20.0	1.0	1.0	0.0
HARRY T. CAMPBELL SONS WHITE MARSH	1	35	959	558	73	00	1	40	0.0	1.0	0.0	0.0	0.0	0.0
KAISER ALUMINUM AND CHEMICAL CO	2	36	685	509	69	00	3	34	7.0	3.0	17.0	0.0	1.0	0.0
KAISER ALUMINUM AND CHEMICAL CO	2	36	685	509	69	00	3	34	9.0	3.0	17.0	0.0	1.0	0.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	0.0	1.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	0.0	1.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	0.0	1.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	0.0	1.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	8.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	8.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	9.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	8.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	6.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	6.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	6.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	1.0	6.0	0.0	0.0	15192.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	7.0	0.0	0.0	0.0	19284.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	0.0	0.0	0.0	0.0	0.0
KAISER ALUMINUM AND CHEMICAL CO	1	36	685	509	69	00	4	34	0.0	0.0	0.0	0.0	0.0	0.0
SPRING GROVE STATE HOSPITAL	2	37	873	521	72	71	5	35	675.0	105.0	329.0	0.0	10.0	0.0
SPRING GROVE STATE HOSPITAL	2	37	873	521	72	71	5	35	675.0	105.0	329.0	0.0	10.0	0.0
SPRING GROVE STATE HOSPITAL	2	37	873	521	72	71	5	35	675.0	105.0	329.0	0.0	10.0	0.0
[illegible]	2	38	916	506	65	30	2	39	7.0	2.0	12.0	0.0	0.0	0.0
[illegible]	2	38	916	506	65	30	2	39	7.0	2.0	12.0	0.0	0.0	0.0
GREATER BALTIMORE MEDICAL CENTER	3	39	906	558	69	69	58	39	0.0	0.0	0.0	0.0	0.0	0.0
GREATER BALTIMORE MEDICAL CENTER	3	39	906	558	69	69	3	37	19.0	4.0	28.0	0.0	0.0	0.0

In this study only major point sources were considered. (There were approximately 9,000 point sources identified from the tape printout.) Major point sources were defined as those sources emitting more than 25 tons per year of a specific pollutant. All area sources within the SMSA were considered in this study, even if a specific grid did not have emissions totalling 25 tons per year. Table 8 summarizes the type of printout report that was generated from the computer tape, listing only the 25 tons per year point sources. The headings and labels on Table 8 were identical with those of Table 7.

Table 9 summarizes the Baltimore City grid (area) sources. Note that the smallest grid (#20) shows emissions of .03 tons/day (11 tons per year) while the largest grid (#11) emits 0.97 tons per day. The grid number specified in Table 9 refers to the grid identification from Maryland Bureau of Air Quality. There are a total of 137 grids in the entire State of Maryland and this sample page includes all the grids (or area sources) for Baltimore City. Other similar tables were prepared for the five surrounding counties.

For process sources and fuel combustion sources the Maryland emission inventory system provided a stack code with a value between 1 and 7, corresponding to various stack height ranges. For example, a stack code of 3 referred to those stacks that were between 51 and 100 feet high. For this range, the mid-point of 75 feet was assumed for inclusion in the model. For incineration type sources, actual stack heights were listed on the file in the stack code printout. Where the Maryland emission inventory file lacked certain data on stack parameters -- stack diameters, exit velocity, and temperature were estimated from published EPA exhaust gas factors for inclusion in the dispersion model. For future preparation of an AQMP, it would be desirable to verify these exhaust parameters from the State's permit file. For major point sources the assumed effective stack height may be in error and it is emphasized that actual stack parameter data are essential for accurately predicting air quality.

PROJECTED EMISSION INVENTORY

Area sources identified on the computer tape file were presented on a grid basis, but unfortunately, the Maryland grids did not coincide with the

Table 8.

MARYLAND EMISSION INVENTORY
COUNTY = 24

*****SOURCES GREATER THAN 25 TONS PER YEAR FOR SO2 OR PART

PREMISE ID	PREMIS CODE	NO	COORDINAT HOR	VER	YEARS REG	IN	STAK	GRID LOCA	----EMISSION RATE (LB/AVG. DAY)---- SO2	PART	NOX	CO	HC	OTHER
BALTIMORE GAS & ELECTRIC-TERMINAL	2	4	915	540	69	00	5	17	152.0	26.0	333.0	0.0	6.0	0.0
BALTIMORE GAS & ELECTRIC-WESTPORT	2	6	904	521	69	70	4	10	193.0	33.0	430.0	0.0	8.0	0.0
BALTIMORE GAS & ELECTRIC-WESTPORT	2	6	905	522	70	41	6	10	5100.0	267.0	4275.0	0.0	81.0	0.0
BALTIMORE GAS & ELECTRIC-WESTPORT	2	6	905	522	70	40	6	10	4410.0	230.0	3680.0	0.0	70.0	0.0
BALTIMORE GAS & ELECTRIC-WESTPORT	2	6	905	522	70	40	6	10	6620.0	363.0	5530.0	0.0	105.0	0.0
BALTIMORE GAS & ELECTRIC-WESTPORT	2	6	905	522	70	40	6	10	4410.0	230.0	3680.0	0.0	70.0	0.0
BALTIMORE GAS & ELECTRIC-WESTPORT	2	6	904	521	69	69	3	10	658.0	206.0	2140.0	0.0	66.0	0.0
BALTIMORE GAS & ELECTRIC-GOULD ST	2	7	912	521	70	26	6	16	4150.0	52.0	2705.0	0.0	83.0	0.0
BALTIMORE GAS & ELECTRIC-GOULD ST	2	7	912	521	70	52	6	16	18580.0	58.0	12110.0	0.0	373.0	0.0
BALTIMORE GAS & ELECTRIC-GOULD ST	2	7	912	521	70	26	6	16	4150.0	52.0	2705.0	0.0	83.0	0.0
EXXON CO.-USA	2	63	923	526	69	00	2	22	1290.0	100.0	673.0	0.0	20.0	0.0
EXXON CO.-USA	2	63	923	526	69	00	2	22	433.0	80.0	490.0	0.0	14.0	0.0
EXXON CO.-USA	2	63	923	526	69	00	2	22	433.0	80.0	490.0	0.0	14.0	0.0
EXXON CO.-USA	1	63	923	526	73	64	3	22	0.0	163.0	0.0	237.0	293.0	0.0
GAF CORP.	1	71	925	525	69	00	4	22	208.0	51.0	119.0	0.0	3.0	90089.0
GAF CORP.	1	71	925	525	69	00	2	22	208.0	49.0	119.0	0.0	3.0	90089.0
CHEVRON ASPHALT CO.	2	72	920	512	70	71	3	15	874.0	159.0	501.0	0.0	14.0	0.0
CHEVRON ASPHALT CO.	2	72	920	512	70	71	3	15	874.0	159.0	501.0	0.0	14.0	0.0
CHEVRON ASPHALT CO.	1	72	920	512	69	00	5	15	601.0	44.0	344.0	0.0	10.0	0.0
FMC CORP. ORG. CHEM. DIV.	2	73	919	509	69	55	5	14	387.0	71.0	246.0	0.0	9.0	0.0
FMC CORP. ORG. CHEM. DIV.	2	73	919	509	69	55	5	14	387.0	71.0	246.0	0.0	9.0	0.0
FMC CORP. ORG. CHEM. DIV.	2	73	919	509	69	60	5	14	836.0	153.0	532.0	0.0	20.0	0.0
FMC CORP. ORG. CHEM. DIV.	2	73	919	507	72	72	5	14	1490.0	272.0	950.0	0.0	35.0	0.0
OLIN MATHIESON CHEM. CORP.	2	74	920	506	72	72	2	14	613.0	11.0	351.0	0.0	10.0	0.0
OLIN MATHIESON CHEM. CORP.	1	74	920	506	69	42	4	14	5468.0	0.0	0.0	0.0	0.0	6090.0
OLIN MATHIESON CHEM. CORP.	1	74	920	506	69	44	4	14	9590.0	0.0	0.0	0.0	0.0	6990.0
OLIN MATHIESON CHEM. CORP.	1	74	920	506	69	48	4	14	15970.0	0.0	0.0	0.0	0.0	6990.0
ALLIED CHEMICAL CORP.	2	75	905	530	69	00	4	10	361.0	66.0	207.0	0.0	6.0	0.0
ALLIED CHEMICAL CORP.	1	75	905	530	69	00	4	10	224.0	250.0	142.0	0.0	4.0	0.0
ALLIED CHEMICAL CORP.	1	75	905	530	69	00	4	10	224.0	250.0	142.0	0.0	4.0	0.0
DAVISON CHEMICAL (W.R. GRACE)	1	76	924	500	69	00	3	20	0.0	158.0	0.0	0.0	0.0	0.0
AGRICO CHEMICALS CO.	1	99	922	522	69	00	6	22	865.0	0.0	135.0	0.0	0.0	0.0
CONTINENTAL OIL CO.	2	100	912	515	69	00	5	15	205.0	15.0	372.0	0.0	15.0	0.0
CONTINENTAL OIL CO.	2	100	912	515	69	00	5	15	205.0	15.0	372.0	0.0	15.0	0.0
CONTINENTAL OIL CO.	2	100	912	515	69	00	5	15	205.0	15.0	372.0	0.0	15.0	0.0
CONTINENTAL OIL CO.-CHEMICALS	1	100	919	511	73	68	4	15	1020.0	14.0	1150.0	55.0	41.0	0.0
AMERICAN SMELTING & REFINING CO.	2	108	928	526	71	71	2	22	168.0	54.0	256.0	0.0	7.0	0.0
AMERICAN SMELTING & REFINING CO.	2	108	928	525	71	71	2	22	168.0	54.0	256.0	0.0	7.0	0.0
AMERICAN SMELTING & REFINING CO.	1	108	928	526	69	00	5	22	360.0	33.0	132.0	3.0	3.0	0.0
AMERICAN SMELTING & REFINING CO.	1	108	928	526	69	00	5	22	360.0	33.0	132.0	3.0	3.0	0.0
AMERICAN SMELTING & REFINING CO.	1	108	928	526	69	00	5	22	140.0	15.0	91.0	3.0	3.0	0.0
AMERICAN SMELTING & REFINING CO.	1	108	928	526	69	00	5	22	140.0	15.0	91.0	3.0	3.0	0.0
AMERICAN SMELTING & REFINING CO.	1	108	928	526	69	22	5	22	167.0	2.0	110.0	825.0	0.0	0.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	6	20	0.0	480.0	0.0	0.0	0.0	19011.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	6	20	350.0	72.0	0.0	54800.0	21.0	13001.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	5	20	960.0	0.0	0.0	0.0	0.0	0.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	5	20	960.0	0.0	0.0	0.0	0.0	0.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	5	20	960.0	0.0	0.0	0.0	0.0	0.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	5	20	960.0	0.0	0.0	0.0	0.0	0.0
GLIDDEN-DURKEE-HAWKINS POINT	1	109	925	500	69	69	5	20	960.0	0.0	0.0	0.0	0.0	0.0

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Table 9. BALTIMORE CITY GRID SOURCES

MARYLAND AREA SOURCES

EMISSIONS (TONS/DAY)

GRID NO.	PART	SO2	CO	NOX	HC
1	0.13	0.18	11.22	1.41	1.80
2	0.19	0.28	16.83	2.11	2.70
3	0.18	0.28	15.58	1.95	2.50
4	0.26	0.37	21.82	2.75	3.51
5	0.25	0.40	19.97	2.55	3.23
6	0.63	1.11	48.64	6.16	7.85
7	0.34	0.57	26.81	3.40	4.32
8	0.29	0.44	24.31	3.06	3.91
9	0.14	0.25	10.64	1.41	1.73
10	0.26	0.49	16.94	2.26	2.79
11	0.97	1.67	73.56	9.30	11.86
12	0.53	0.92	41.77	5.29	6.73
13	0.16	0.23	14.33	1.79	2.30
14	0.07	0.16	4.38	0.60	0.71
15	0.12	0.24	7.58	1.07	1.25
16	0.24	0.44	14.50	1.98	2.44
17	0.86	1.39	66.76	8.47	10.78
18	0.44	1.06	29.92	4.00	4.82
19	0.41	0.59	35.52	4.47	5.71
20	0.03	0.14	0.04	0.09	0.03
21	0.20	0.89	0.92	0.70	0.33
22	0.23	0.45	16.26	2.16	2.65
23	0.35	0.55	28.71	3.66	4.64
24	0.44	0.61	38.02	4.78	6.11
25	0.43	0.65	36.77	4.63	5.91

regional planning district (RPD) boundaries identified for the Baltimore SMSA by the Planning Commission. Figure 5 illustrates the problem encountered in relating planning district growth data to the Maryland grid emission data. In this study, emissions from each of the grids were proportioned on an area basis to each of the regional planning districts before making growth projections on air quality from area type sources. Several simple computer programs were developed to make projections based on planning data. Table 10 is a sample of the output of program P1985 which takes planning data and existing area source emissions to project future emissions by year (in the example 1977) for each grid. The heading "TGFC" refers to the total growth factor for cars. Similarly, the headings continue for trucks (TGFT), home or residential sources (TGFH), and small commercial sources (TGFS). "CARS," "TRUCKS," etc. refer to the projection data for each of these classes. For cars and trucks the projection and data are in 1,000's of VMT. For "HOME" the data are dwelling units and for "SMALL" (small commercial facilities), the data represent employment. The table also includes the splits for emissions from cars (EM-C) trucks (EM-T), etc. in tons per day. The projected emission total for the grid for that year is listed in the far right column. When no projection data were available a message was presented for that grid (e.g. "no projection found for grid xxx"). In such cases, growth was assumed to be 1.0 for the grids.

The current emission inventory is given in Table 11. Planning data were used to make computer projections by each regional planning district, based on:

(1) Residential heating - number of dwelling units

(2) Small commercial - employment (extensive)

(3) Industrial processes - manufacturing employment (intensive)

(4) Cars - vehicle miles traveled (light duty)

(5) Trucks - vehicle miles traveled (medium and heavy duty)

Planning data were available to project emissions for only about one-third of the base year emissions. To project the remaining two-thirds of the emissions to future years, growth factors were used as follows:

Table 10. PROJECTED AREA SOURCE EMISSIONS FOR 1977 BASED ON PLANNING DATA

YEAR	GRID	TGPC	TGPT	TGPH	TGPS	CARS	TRUCKS	HOME	SMALL	EM-C	EM-T	EM-N	EM-S	EM-O	PROJ EMIS
1977.	1.	2.1	2.1	1.1	1.2	43.9	11.0	7360.0	12033.0	0.1	0.0	0.0	0.0	0.0	0.10
1977.	2.	0.9	0.9	1.2	1.3	54.7	13.7	23376.0	9662.0	0.1	0.0	0.1	0.1	0.0	0.07
1977.	3.	1.3	1.3	1.2	1.0	54.7	13.7	23376.0	9662.0	0.1	0.0	0.0	0.1	-0.0	0.10
1977.	4.	1.1	1.1	1.2	1.0	16.1	4.0	7843.0	3153.0	0.1	0.0	0.1	0.1	0.0	0.13
1977.	5.	2.1	2.1	1.1	1.2	43.9	11.0	7360.0	12033.0	0.1	0.0	0.1	0.1	0.0	0.21
1977.	6.	1.5	1.5	1.2	0.9	42.0	10.5	18378.0	10109.0	0.2	0.0	0.2	0.1	0.0	0.36
1977.	7.	1.1	1.1	1.3	1.0	32.3	8.1	8439.0	10908.0	0.1	0.0	0.1	0.1	0.0	0.15
1977.	8.	1.2	1.2	1.1	1.0	25.2	6.3	16506.0	9060.0	0.1	0.0	0.1	0.1	0.0	0.14
1977.	9.	1.1	1.1	1.2	1.0	41.1	10.3	9755.0	8436.0	0.1	0.0	0.0	0.0	0.0	0.05
1977.	10.	1.8	1.8	1.1	1.1	33.0	8.3	8283.0	21678.0	0.1	0.0	0.1	0.1	0.0	0.15
1977.	11.	1.2	1.2	1.3	1.3	49.2	12.3	3565.0	18694.0	0.4	0.1	0.3	0.2	0.0	0.44
1977.	12.	1.1	1.1	1.3	1.0	57.6	13.4	18659.0	33948.0	0.2	0.0	0.2	0.1	0.0	0.22
1977.	13.	1.1	1.1	1.1	0.4	47.8	11.9	8528.0	3153.0	0.1	0.0	0.0	0.0	-0.0	0.08
NO PROJECTION FOUND FOR GRID 14.															
1977.	14.	1.0	1.0	1.0	1.0	47.8	11.9	8528.0	3153.0	0.0	0.0	0.0	0.0	0.0	0.02
1977.	15.	1.2	1.1	1.1	0.9	70.9	15.9	7277.0	12553.0	0.0	0.0	0.0	0.0	0.0	0.05
ERROR ENCOUNTERED WITH 15. EXEC. CONTINUING															
1977.	16.	2.0	2.0	1.2	1.3	33.0	8.3	8283.0	21678.0	0.1	0.0	0.1	0.0	0.1	0.14
1977.	17.	1.1	1.1	1.0	0.9	41.5	10.4	17797.0	15725.0	0.3	0.0	0.3	0.2	0.1	0.35
1977.	18.	1.0	1.0	1.1	1.0	23.1	5.8	8188.0	4519.0	0.1	0.0	0.1	0.1	0.1	0.15
1977.	19.	1.0	1.0	1.1	1.0	41.0	10.3	13997.0	7230.0	0.2	0.0	0.1	0.1	0.0	0.18
NO PROJECTION FOUND FOR GRID 20.															
1977.	20.	1.0	1.0	1.0	1.0	41.0	10.3	13997.0	7230.0	0.0	0.0	0.0	0.0	0.0	0.0
1977.	21.	1.2	1.1	1.1	0.9	70.9	15.9	7277.0	12553.0	0.0	0.0	0.0	0.0	0.2	0.0
1977.	22.	1.3	1.3	1.0	1.0	147.3	36.8	8219.0	54000.0	0.1	0.0	0.1	0.1	0.0	0.10
1977.	23.	1.2	1.2	1.0	1.0	41.5	10.4	17797.0	15725.0	0.1	0.0	0.1	0.1	0.0	0.17
1977.	24.	1.0	1.0	1.1	1.0	52.6	13.2	19478.0	7513.0	0.2	0.0	0.1	0.1	0.0	0.19
1977.	25.	1.0	1.0	1.1	0.9	52.6	13.2	19478.0	7513.0	0.2	0.0	0.1	0.1	0.0	0.18
NO PROJECTION FOUND FOR GRID 26.															
1977.	26.	1.0	1.0	1.0	1.0	52.6	13.2	19478.0	7513.0	0.1	0.0	0.0	0.0	0.0	0.14
ERROR ENCOUNTERED WITH 26. EXEC. CONTINUING															

Table 10. PROJECTED AREA SOURCE EMISSIONS FOR 1977 BASED ON PLANNING DATA (continued)

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YEAR   GRID    TGPC    TGPT    TGPR    TGPS    CARS   TRUCKS   HOME    SMALL    EM-C    EM-T    EM-B    EM-S    EM-O   PROJ EMIS
  NO PROJECTION FOUND FOR GRID  27.
 1977.   27.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.1     0.0     0.0     0.0     0.0     0.11
 ERROR ENCOUNTERED WITH   27. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  28.
 1977.   28.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.1     0.0     0.0     0.0     0.0     0.06
  ERROR ENCOUNTERED WITH   28. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  29.
 1977.   29.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.2     0.0     0.1     0.0     0.1     0.23
  ERROR ENCOUNTERED WITH   29. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  30.
 1977.   30.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.6     0.0     0.1     0.1     0.0     0.58
  ERROR ENCOUNTERED WITH   30. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  31.
 1977.   31.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.5     0.0     0.1     0.0     0.0     0.48
  ERROR ENCOUNTERED WITH   31. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  32.
 1977.   32.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.6     0.0     0.2     0.1     0.0     0.61
  ERROR ENCOUNTERED WITH   32. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  33.
 1977.   33.     1.0     1.0     1.0     1.0    52.6    13.2 19478.0  7513.0    0.5     0.0     0.1     0.0     0.0     0.53
  ERROR ENCOUNTERED WITH   33. EXEC. CONTINUING
 1977.   34.     1.4     1.4     1.3     0.9   150.6    37.6 10303.0  8665.0    0.2     0.0     0.1     0.1     0.1     0.30
 1977.   35.     1.4     1.4     1.3     1.2    75.9    19.0 13631.0 11809.0    0.6     0.1     0.3     0.2     0.2     0.88
 1977.   36.     1.6     1.6     1.5     1.1   138.6    34.6 12066.0 12793.0    0.2     0.1     0.1     0.1     0.1     0.40
 NO DATA FOR RPD 301
 NO DATA FOR RPD 302
 1977.   37.     1.7     1.7     1.7     1.5    12.7     3.2  2101.0  1038.0    0.1     0.0     0.1     0.0     0.0     0.12
 1977.   38.     1.4     1.4     1.4     1.1    34.3     8.6  1507.0   895.0    0.2     0.0     0.1     0.1     0.0     0.23
 1977.   39.     1.3     1.3     1.4     1.1   106.3    25.6 24824.0 44483.0    0.8     0.1     0.3     0.2     0.2     1.01
 1977.   40.     1.3     1.3     1.5     1.1    39.4     9.6 16479.0  6815.0    0.6     0.1     0.3     0.2     0.2     0.62
 1977.   41.     1.2     1.2     1.1     0.9    18.6     4.6  3938.0 33295.0    0.4     0.1     0.2     0.1     0.7     0.48
 NO PROJECTION FOUND FOR GRID  42.
 1977.   42.     1.0     1.0     1.0     1.0    18.6     4.6  3938.0 33295.0    0.2     0.0     0.1     0.0     0.0     0.17
  ERROR ENCOUNTERED WITH   42. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  43.
 1977.   43.     1.0     1.0     1.0     1.0    18.6     4.6  3938.0 33295.0    0.3     0.0     0.1     0.0     0.1     0.31
  ERROR ENCOUNTERED WITH   43. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  44.
 1977.   44.     1.0     1.0     1.0     1.0    18.6     4.6  3938.0 33295.0    0.6     0.0     0.2     0.0     0.2     0.55
 ERROR ENCOUNTERED WITH   44. EXEC. CONTINUING
 NO PROJECTION FOUND FOR GRID  45.
 1977.   45.     1.0     1.0     1.0     1.0    18.6     4.6  3938.0 33295.0    0.7     0.0     0.2     0.0     2.8     0.71
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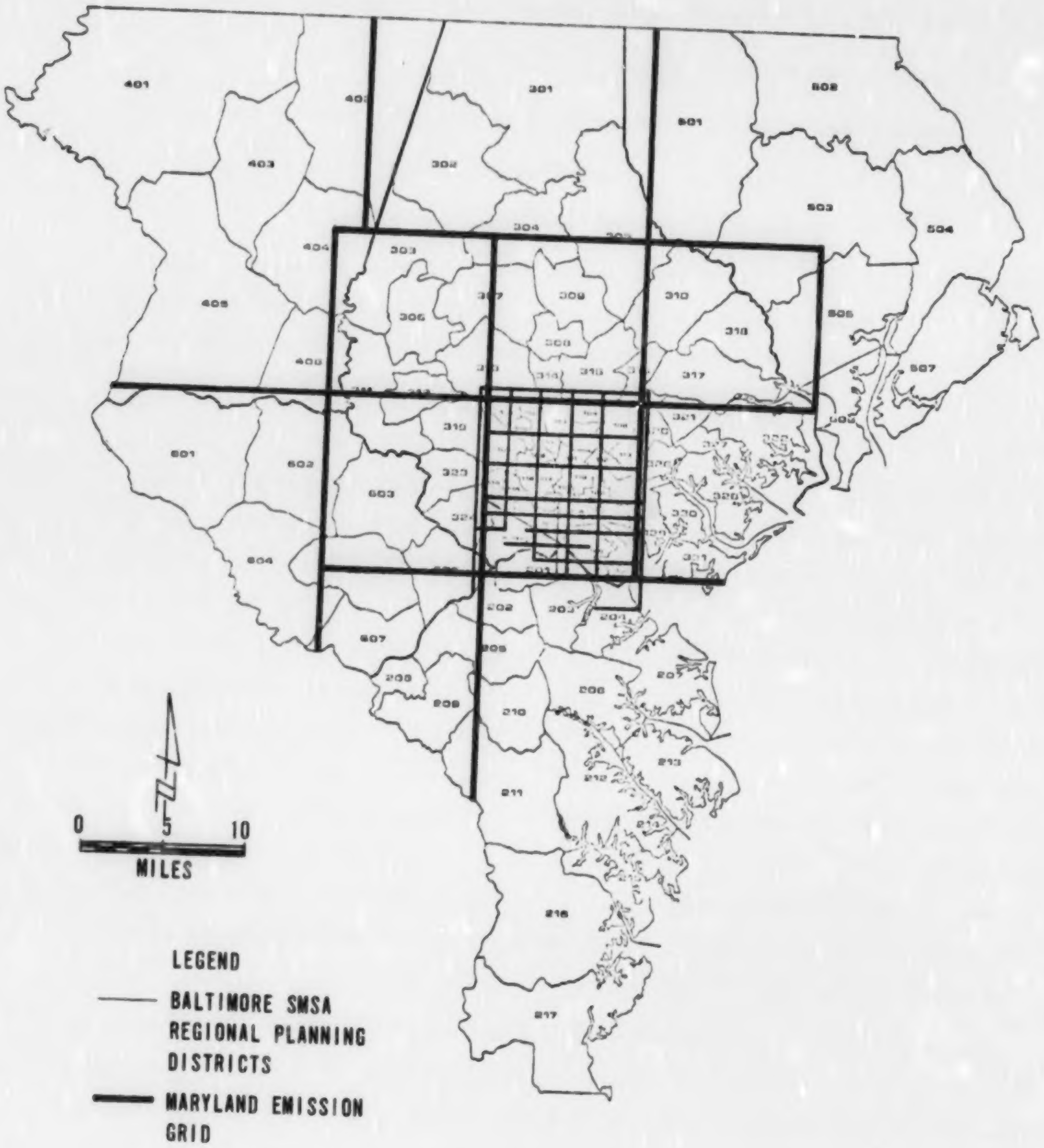
Table 11. BALTIMORE AQMA PARTICULATE EMISSIONS FOR 1973
(tons/year)

	Anne Arundel County	Baltimore County	Carroll County	Harford County	Howard County	Baltimore City	Regional total
Fuel combustion stationary sources							
Residential	210	567	146	106	62	990	2,081
Commercial/Institutional	394	685	129	142	39	1,121	2,510
Industrial	55	1,264	18	25	55	783	2,200
Power plants	487	510	0	124	0	356	1,477
Total stationary fuel combustion	1,146	3,026	293	397	156	3,250	8,268
Industrial process	177	15,719	4,744	180	72	2,434	23,326
Solid waste disposal	154	257	28	46	28	3,032	3,545
Transportation	3,299	1,677	162	238	135	1,525	7,036
Miscellaneous	0	0	0	0	0	0	0
Totals	4,776	20,679	5,227	861	391	10,241	42,175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MILES
LEGEND
BALTIMORE SMSA REGIONAL PLANNING DISTRICTS
MARYLAND EMISSION GRID

Figure 5. Baltimore SMSA regional planning districts and Maryland emission grids

(1) Residential heating - population growth for rural counties

(2) Small commercial - regional employment

(3) Industrial heating - regional manufacturing employment

(4) Industrial processes (sources less than 25 tons per year) - regional manufacturing employment.

Particulate emissions from power plants for 1973 were obtained from the Maryland emission inventory. Future or projected power plant emissions for 1977, 1980, and 1985 were obtained from Federal Power Commission Form 67. (The FPC requests projections of generating capacity as well as future emissions.)

Table 12 summarizes the gross projected emissions for all source categories through 1985. On a grid-by-grid basis, projections were made from the Planning Commission data. For example, in the base year there were 6,508 dwelling units located in RPD #101. The projection for 1977 indicated a growth to 7,843 dwelling units. RPD #101 is a part of Grid #4 which also includes 10 percent of RPD #107. By weighted averages the emissions increase for Grid #4 was determined to be 1.2. In the base year, residential home heating emissions totaled 0.06 tons per day of particulate emissions. The projected 1977 emissions for Grid #4 were, thereby, calculated to be 0.072 (0.06 x 1.2) tons per day. In a similar manner, projections were determined for all grids and all source categories. However, several grids, especially in the more rural areas, did not have planning agency projection information.

All emissions were summed for the base years of those grids which had projection data; for those grids which had no projection data a generalized growth factor was applied. These computer projections and the generalized projections by source category were summed by source category for 1977, 1980, and 1985 (Table 12). The computer projected values were considered most accurate because they were determined discretely, grid-by-grid. However, the generalized growth factors produced essentially the same rates of increases in emission rates.

Projections of industrial emissions in this analysis were not considered totally accurate for the Baltimore AQMA. For cities less industrialized,

Table 12. BALTIMORE AQMA PARTICULATE EMISSIONS FOR FUTURE YEARS (tons/year)

	1973		1977		1980		1985	
Fuel combustion								
Residential	2,081		2,562		2,738		3,036	
(a)		1,752		2,194		2,336		2,573
(b)		329		368		402		463
Commercial	2,510		2,745		2,881		3,351	
(c)		1,129		1,263		1,318		1,624
(d)		1,381		1,482		1,363		1,727
Industrial (e)	2,200		2,222		2,278		2,336	
Power plants	1,477		1,546		1,982		2,522	
Industrial processes	23,326		23,731		23,761		25,691	
(c)		3,570		3,577		3,303		4,716
(d)		19,756		20,154		20,458		20,975
Refuse disposal	3,545		2,530		2,530		2,530	
Transportation								
(g)		3,588		4,719		5,517		5,570
(h)		3,448		3,697		4,105		4,251
Totals	42,175		43,752		45,432		49,287	

Basis of projections
(a) Based on dwelling units by RPD - computerized
(b) Based on population change for Harford and Carroll County from RPC.
(c) Based on manufacturing employment by RPD - computerized
(d) Based on manufacturing employment of entire region.
(e) Based on Maryland BAQ data
(f) Based on Federal Power Commission
(g) Based on VMT by RPD - computerized
(h) Based on 1.76 percent per year growth (ships, planes, trains, etc.)

a methodology based on manufacturing employment may be adequate. In Baltimore, however, a major portion of all particulate emissions was generated from industrial point sources. In 1973, some 9,000 industrial sources discharged 88 tons per day out of a total of 115 tons per day discharged for the AQMA.

In addition, some plants in the AQMA were developing or installing air pollution abatement equipment and plans for compliance had been filed with the Maryland Bureau of Air Quality. Reductions contemplated from those sources on a compliance schedule, which emitted more than 25 tons per year, were incorporated into the emission inventory for the year 1977. It was assumed that a 90 percent reduction in particulate emissions would occur at each plant which had a compliance schedule on file with the Bureau of Air Quality. The compliance schedules themselves did not indicate which processes were being controlled.

RELATING EMISSIONS TO AIR QUALITY USING AQDM

To calibrate the air quality display model (AQDM), ES used emissions from most of the residential sources, one-half of the transportation sources (all cars and trucks but no ships, trains, and planes), one-half of the commercial sources, 12 percent of industrial point sources (all over 25 tons per year), and all of the power plant sources. These emissions totalled 37 tons per day or 32 percent (37/115) of the actual total emissions in the AQMA (Table 13). There were 131 sources included in the AQDM model, of which approximately 50 were area type sources and 81 were point sources.

Had computer files not been available for the Baltimore AQMA, calibration of the AQDM would have been nearly impossible. For other air quality maintenance programs developed in the future it is suggested that the small sources be lumped together for each grid and entered as an area source. For example, in the Baltimore SMSA there were approximately 55 grid locations (sections of the county, city blocks, etc.). Those small point sources emitting less than 25 tons per day could then be distributed among the 55 grid locations and included in the AQDM for calibration purposes. Because of time limitations imposed on the preparation of this trial plan, no attempts were made to spread the remaining omitted sources to each of the grid locations for subsequent computer runs.

Table 13. BALTIMORE AQMA PARTICULATE EMISSIONS FOR 1973 UTILIZED IN THE AQDM TO OBTAIN CALIBRATION OF THE MODEL

Source category	Emissions (tons/year)	Emissions (tons/day)
Power plants (a)	3,409	9.34
Industrial plants (b)	3,570	9.78
Commercial	1,128	3.09
Residential	1,752	4.80
Cars (c)	3,110	8.52
Trucks (c)	478	1.31
Totals	13,447	36.84

(a) Data obtained from FPC form 67

(b) Represents only 12 percent (9.78/88) of the total of this category

(c) Base year emission inventory for mobile sources was calculated from 1970 data

The AQDM calibration factor was obtained using ambient air quality data from 29 stations located throughout the metropolitan area. The AQDM compared predicted concentrations with measured concentrations (Table 14).

A best fit linear relationship of observed versus predicted concentrations was developed by the AQDM (Figure 6).

In the equation:

$$Y = 41.8 + 3.1234 X$$

where: Y is the observed concentration and
X is the computer predicted concentration,

the y intercept in Figure 6 of 41.8 $\mu g/m^3$ represents background concentrations. The background level identified in the calibration was fairly consistent with background levels measured at rural stations throughout the State of Maryland as tabulated below:

Station	Concentrations ($\mu g/m^3$) 1973	1974 (1st qtr)
Harwood	33	38
Oakland	32	36
Accokeek	34	39
Friendship Rd. (Eastern Shore)	30	40

PROJECTED ANNUAL AIR QUALITY

Using the computer projected emission data of Table 12 as input, the AQDM was run to predict ground level particulate concentrations on an annual basis. Concentration isopleths were prepared for each source category so that various control strategies could later be analyzed for their impact on reducing not only emissions but also air quality levels. The projected concentration isopleths for each source category are illustrated in Figures 7 through 13 on the following pages. As expected the maximum concentrations from area sources were located near the downtown area. Because only a portion of the actual emission data was used in the calibration, the predicted concentration levels were proportioned upward to the anticipated totals for all categories. For example, residential home heating emissions in 1985

Table 14. COMPARISON OF OBSERVED AND PREDICTED PARTICULATE CONCENTRATIONS IN THE BALTIMORE AQMA

Station location	Receptor location (kilometers)		Particulate concentration $\mu g/m^3$		
	Horizontal	Vertical	Observed	Computer predicted	Computer corrected*
Anne Arundle Co.					
Glen Burnie	358.9	4337.2	79	9	69
Harmons	355.0	4334.5	69	7	63
Harwood	359.4	4303.0	38	3	51
Linthicum	357.3	4341.4	77	9	69
Odenton	354.1	4325.9	55	6	60
Riviera Beach	369.4	4335.4	58	9	69
St. Johns	369.7	4315.6	60	4	54
Baltimore Co.					
Catonsville	349.9	4348.0	47	8	66
Cockeyesville	357.7	4372.2	61	6	60
Essex	372.4	4356.8	80	11	75
Garrison	348.0	4363.1	82	5	57
Landsdowne	357.1	4344.1	73	10	72
Solless Point	369.7	4344.7	78	13	81
Middle River	378.6	4354.8	67	10	72
Towson	362.5	4363.1	51	8	66
Baltimore City					
Fire Dept. Hq.	361.2	4350.1	97	14	84
Fire Dept. #10	363.0	4344.1	151	12	78
John Hopkins	362.7	4350.8	76	18	96
Morgan	363.7	4356.2	59	12	78
NW Police Station	354.7	4356.2	80	9	69
NE Police Station	363.6	4355.5	66	12	78
SE Police Station	366.5	4349.6	102	15	87
SW Police Station	356.5	4348.7	84	11	75
Poly	363.4	4356.2	66	12	78
State Ofc. Bldg.	360.1	4351.3	85	18	96
Carroll Co.					
Westminister	329.0	4380.4	46	4	54
Harford Co.					
Bel Air	384.1	4376.9	57	5	57
Whiteford	384.8	4395.6	44	3	51
Howard					
Simpsonville	337.6	4338.9	53	5	57

*Computer corrected equals computer predicted times 3.1 plus background of 41.8 $\mu g/m^3$.

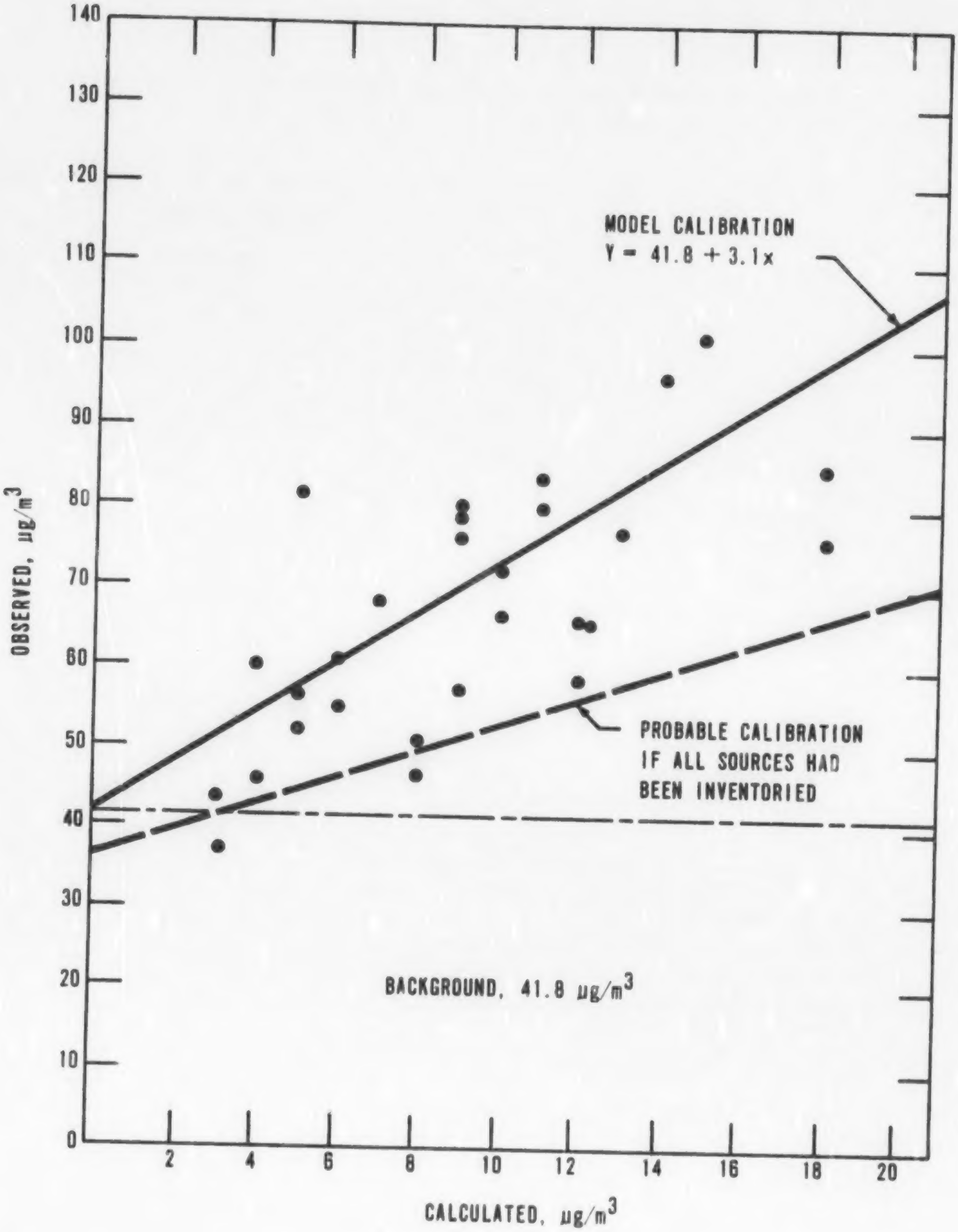
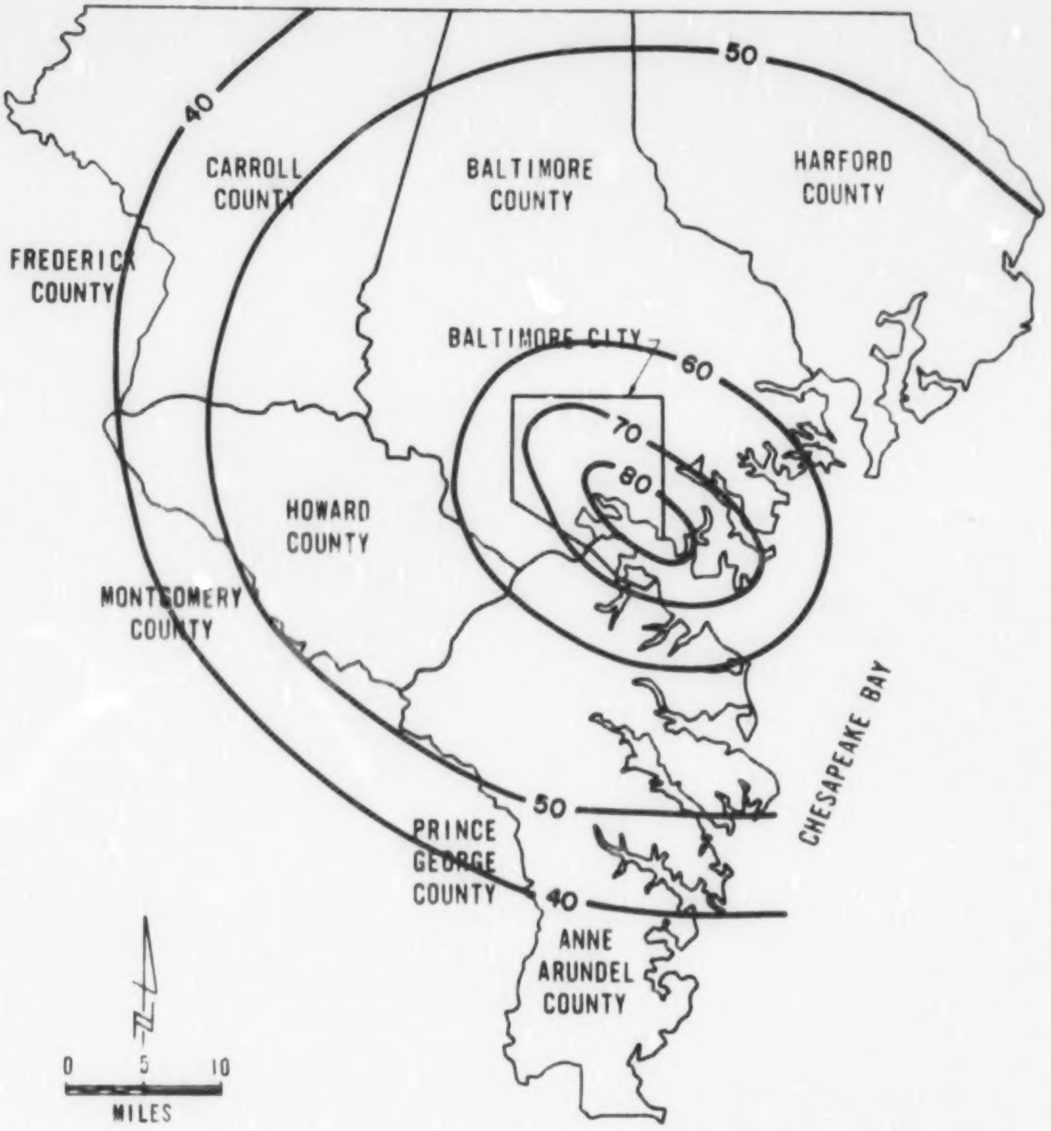
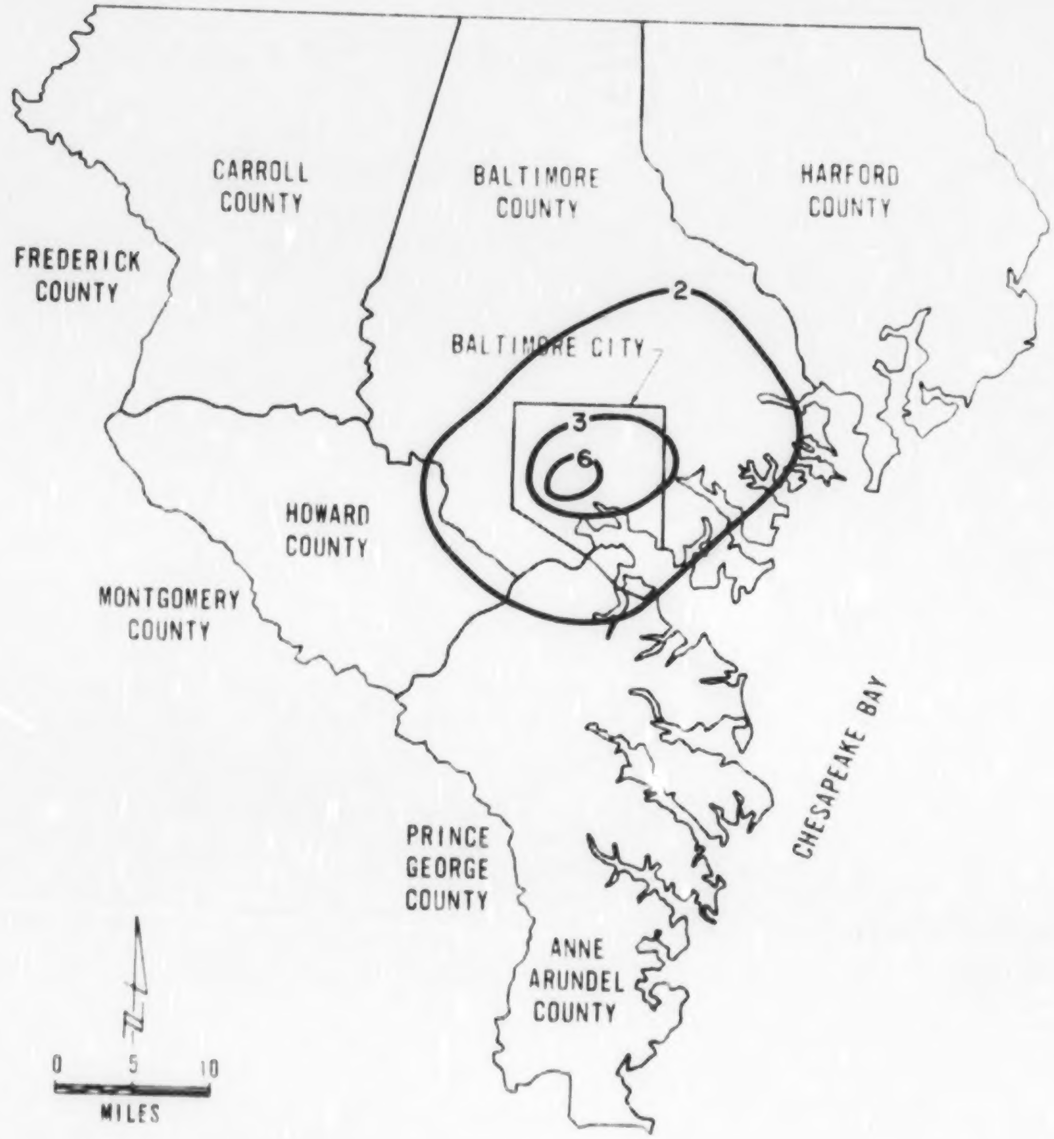


Figure 6. Comparison of observed and predicted particulate concentrations in the Baltimore AQMA–1973


40
50
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
60
70
80
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
50
PRINCE GEORGE COUNTY
40
ANNE ARUNDEL COUNTY
0
5
10
MILES

NOTE: INCLUDES EMISSIONS FROM SHIPS, PLANES, AND TRAINS AND FROM FUGITIVE DUST SOURCES AND FROM BACKGROUND .

Figure 7. Average annual concentrations of particulates from all sources in 1985 ($\mu g/m^3$)


FREDERICK COUNTY
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
BALTIMORE CITY
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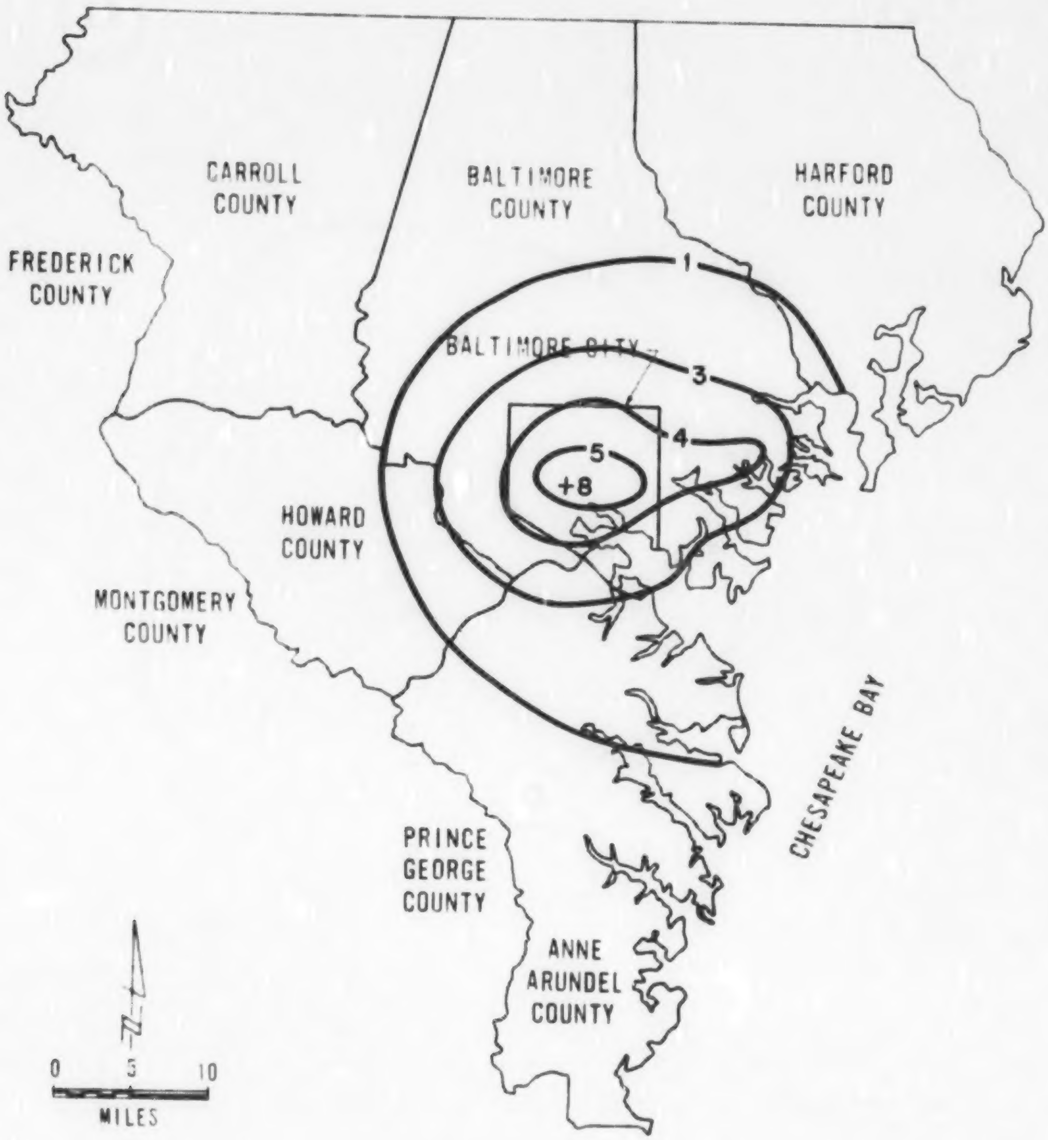
3
6
HOWARD COUNTY
MONTGOMERY COUNTY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
CHESAPEAKE BAY
N
0
5
10
MILES

Figure 8. Average annual concentrations of particulates from 1985 domestic sources ($\mu g/m^3$)


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
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3
4
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+8
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
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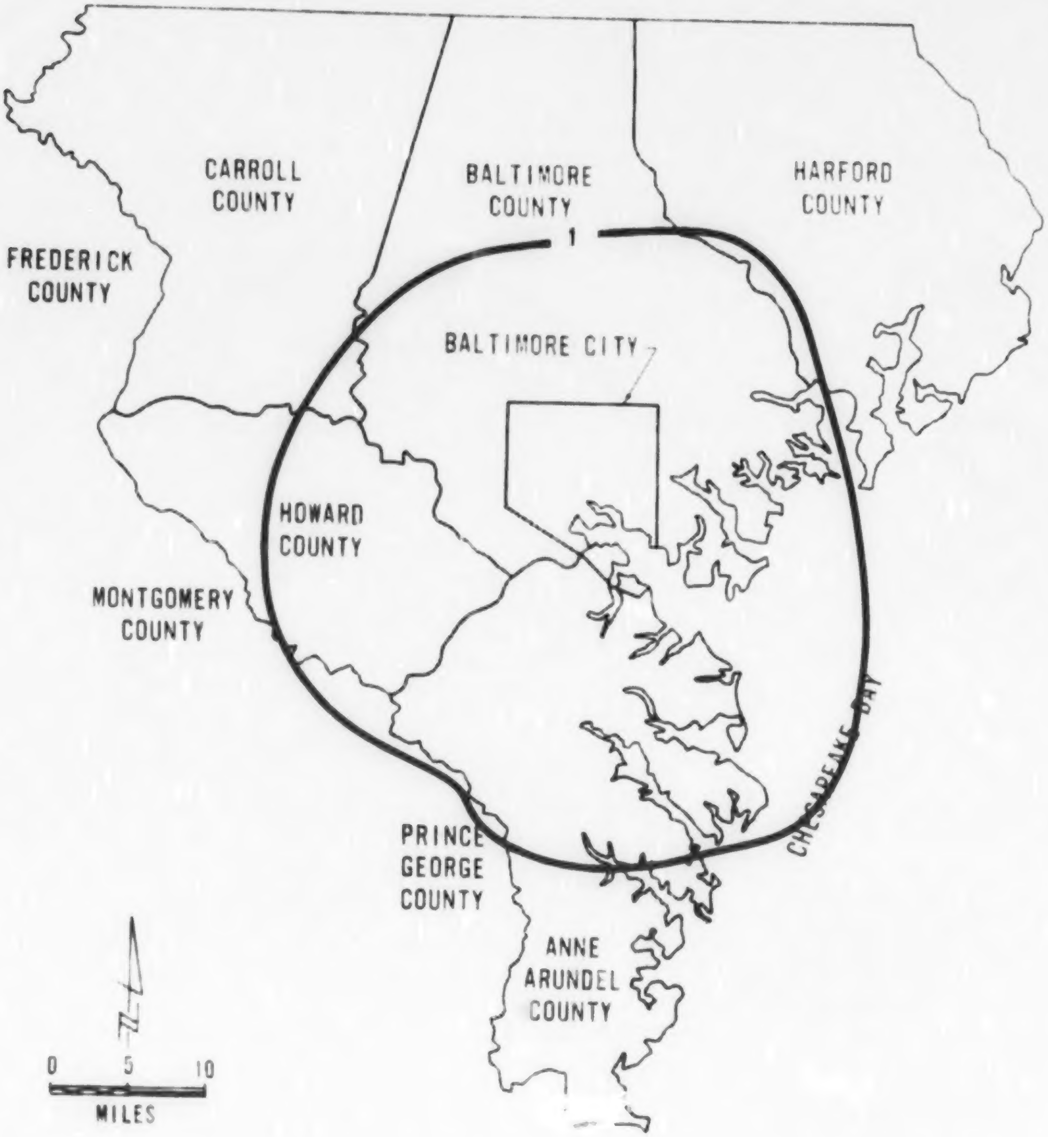
0
5
10
MILES

Figure 9. Average annual concentrations of particulates from 1985 commercial sources ($\mu g/m^3$)


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
1
BALTIMORE CITY
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
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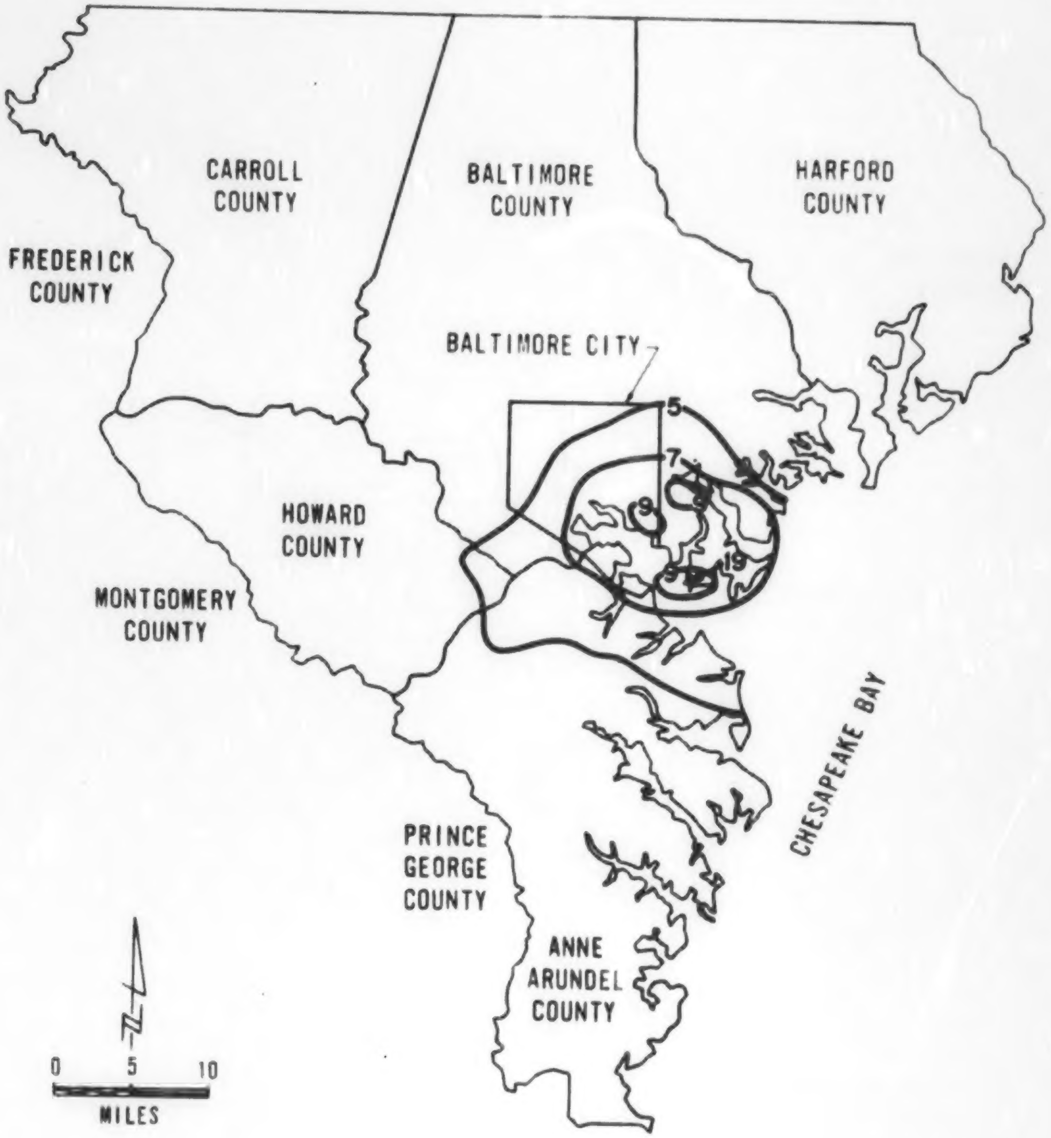
0
5
10
MILES

Figure 10. Average annual concentrations of particulates from 1985 power plant sources ($\mu g/m^3$)


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
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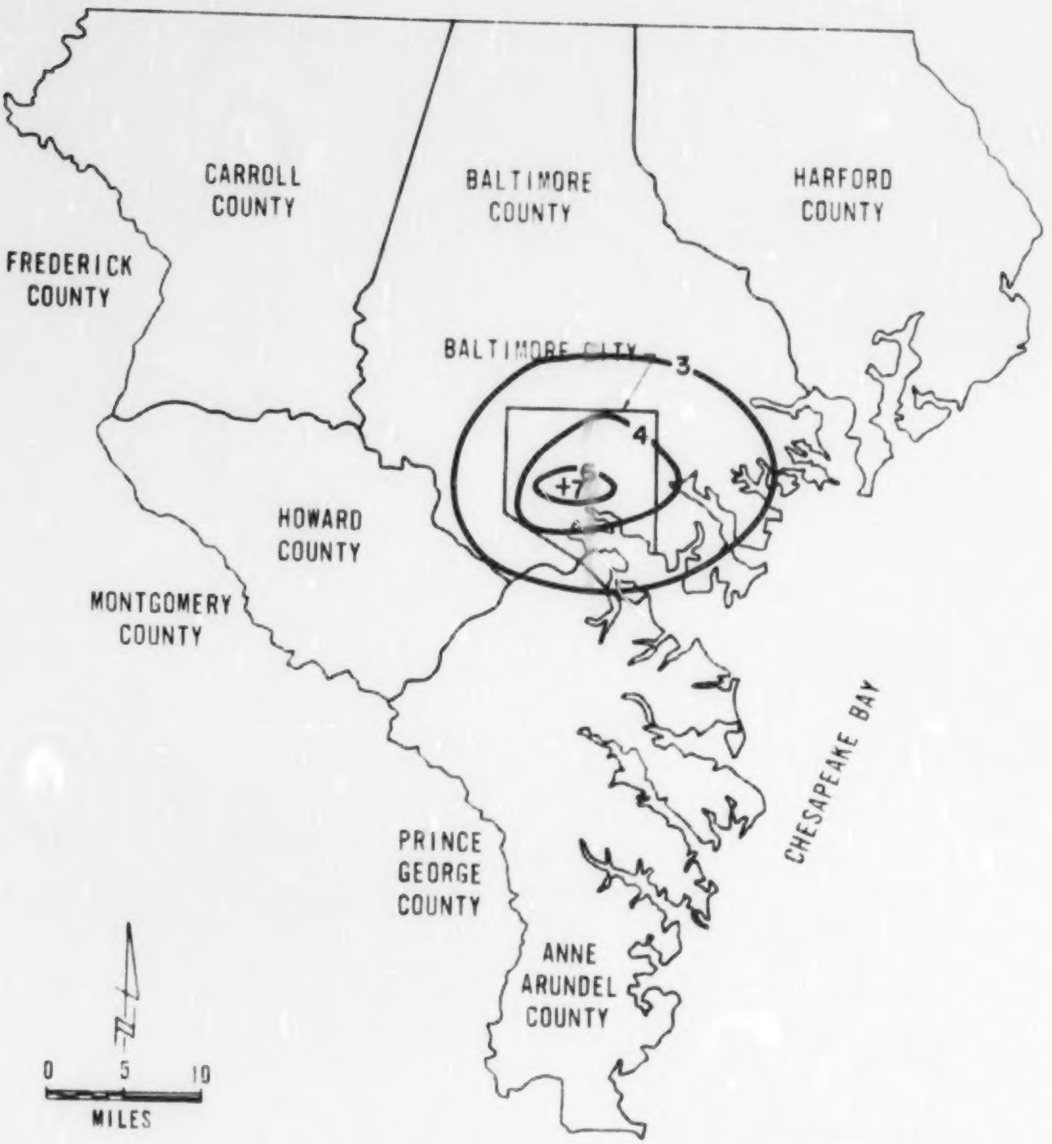
7
9
9
19
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
0
5
10
MILES

Figure 11. Average annual concentrations of particulates from 1985 industrial sources (µg/m^3)


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
3
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+7
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
N
0
5
10
MILES

Figure 12. Average annual concentrations of particulates from cars in 1985 ($\mu g/m^3$)

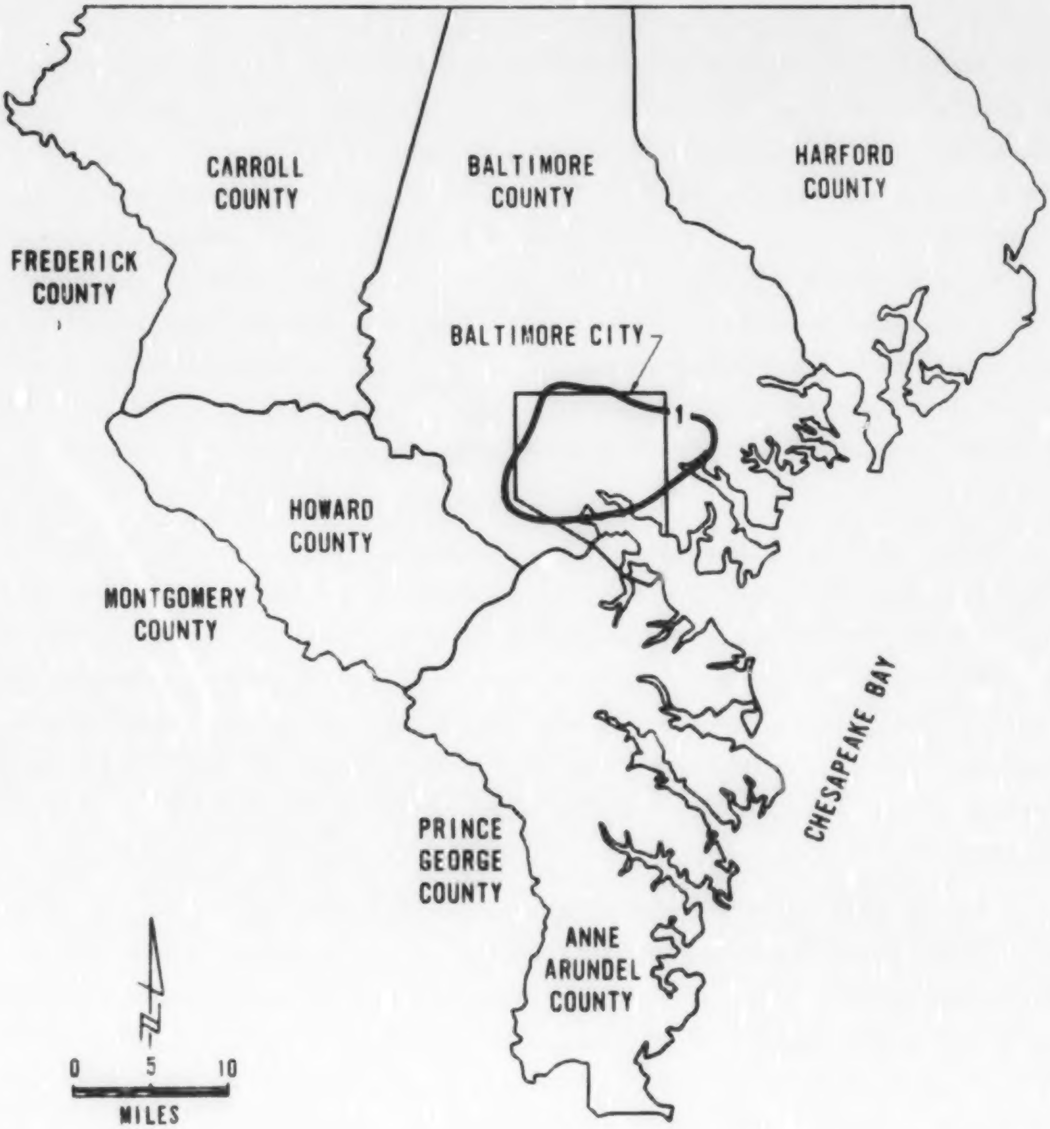
CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
1
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
N
0
5
10
MILES

Figure 13. Average annual concentrations of particulates from trucks in 1985 ($\mu g/m^3$)

were predicted by the AQDM to produce a maximum annual particulate average of 5 $\mu g/m^3$. Because this concentration would result from 85 percent of the emissions, the concentration was increased by 1.17 $(\frac{1}{0.85})$ to 6 $\mu g/m^3$. For the residential and commercial source categories, this proportioning technique would likely result in an overstatement of concentration maximums because emissions in the rural areas of the AQMA would not have significant impact on the downtown area where the maximums occurred. However, for industrial processes the proportioning scheme is probably more adaptable because the 9,000 plants are scattered throughout the metro-Baltimore area and will likely increase production and particulate emissions quite randomly between 1975 and 1985.

Prior to listing and evaluating candidate control measures it was deemed advisable to show projected air quality by source category for 1977 and 1985 at two locations in the Baltimore AQMA (Table 15 and Figure 14). The significant difference between the emission split and the split on air quality impact is the localized influence of motor vehicles and other area sources. Such differences could be important in terms of selecting effective control measures that address those sources responsible for the localized air quality.

Thirty $\mu g/m^3$ were accounted for, 9 $\mu g/m^3$ were estimated, and 41 $\mu g/m^3$ were added for background. However, fugitive dust sources in the AQMA could add somewhat more than the 4 $\mu g/m^3$ and could be contributing significantly to the 41 $\mu g/m^3$ identified as background. From the projection, it would appear that 80 $\mu g/m^3$ will be the air quality level in Baltimore in 1985 unless maintenance measures are implemented.

SHORT TERM AIR QUALITY

For this trial air quality maintenance program for the Baltimore SMSA, no attempt was made to compute 1975 or 1985 short term concentrations of particulates. Several methodologies exist for making such projections for the future periods of 1975 and 1985. One of the easiest methods for estimating short term concentrations is to use existing ambient air quality

Table 15. PROJECTED 1977 and 1985 SUSPENDED PARTICULATE CONCENTRATIONS AT TWO LOCATIONS IN THE BALTIMORE AQMA BY SOURCE CATEGORY CONTRIBUTION
(ug/m^3)

Source category	1977		1985	
	Central business district	Industrial area	Central business district	Industrial area
Residential	6	2	6	2
Commercial	7	2	8	3
Industrial heating	+	+	+	+
Power plants	1	1	1	1
Industrial process	6	45	7	19
Refuse disposal	+	+	+	+
Cars and trucks	7	2	8	4
Ships, planes, trains	3*	4*	5*	6*
Fugitive dust (2)	4*	4*	4*	4*
Subtotal	34	60	39	39
Background (1)	41	41	41	41
Total	75	101	80	80

+ Included in the air quality identified as being due to the industrial process category

* Estimated

(1) Consists of natural background (25 μ/m^3) and fugitive dust (approximately 16 mg/m^3).

(2) Estimated fugitive dust due to city activities in addition to fugitive dust in background.

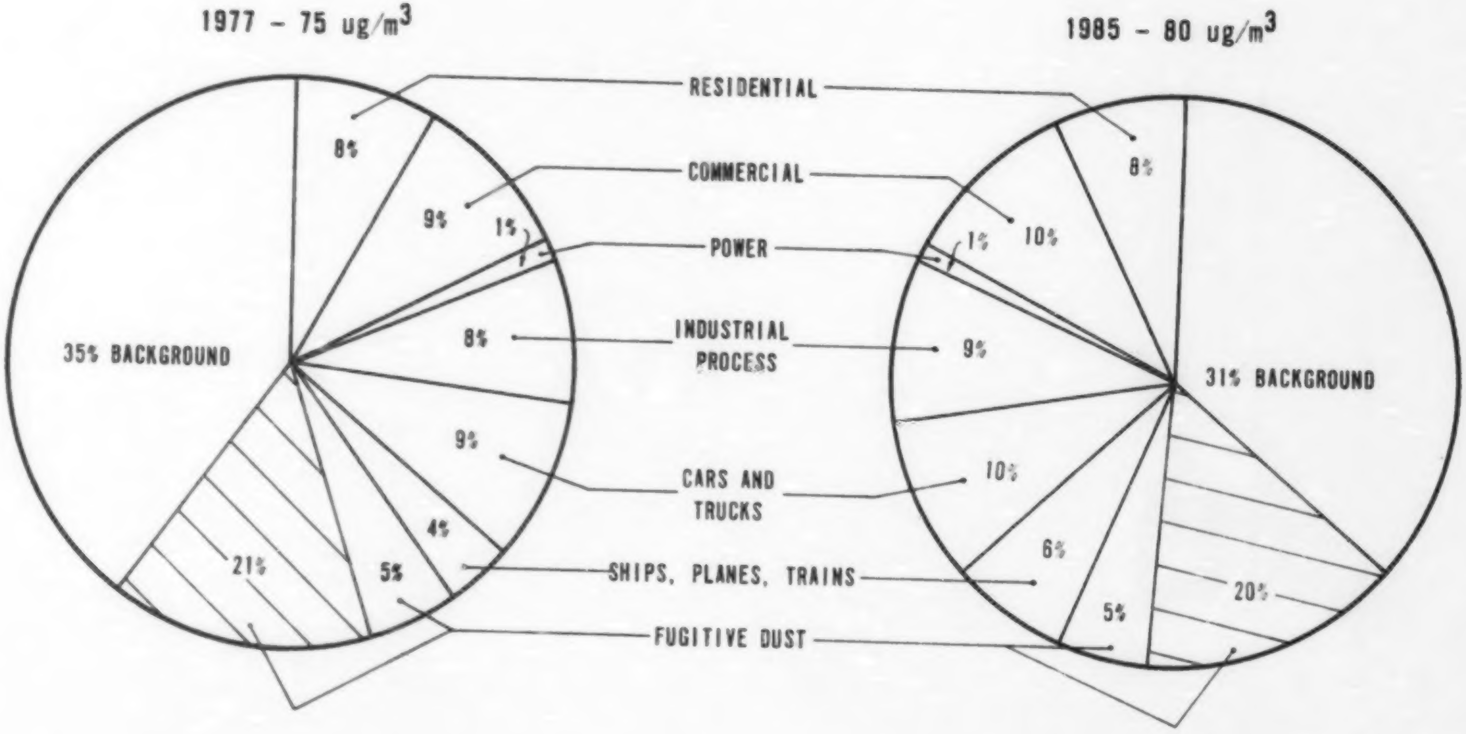

Figure 14. Distribution of particulate concentration in the central business district by source category

data and Larsen's technique* of relating expected maximum annual concentrations to short 1-hour, 3-hour, and 24-hour concentration maximums. This procedure is most appropriate when considering historical data and is most applicable for metropolitan areas. For future periods, where changes in emission rates at many large point sources could be expected, the Larsen technique would not be so applicable.

Several short term dispersion models have been developed by the U.S. Environmental Protection Agency. One model entitled PTMTP could be applied to the Baltimore AQMA. However, considering the number of sources and the inflexibility of the PTMTP model, much time would be required in order to make such short term predictions. A proprietary short term dispersion model entitled APMAX, developed by Engineering-Science, Inc., could have been applied to the Baltimore SMSA for computing the 10 minute, 1-hour, 3-hour, and 24-hour concentrations of particulate and sulfur oxide. Also, the cost of running the APMAX program is inexpensive when compared to the AQDM. For future assessment of the Baltimore maintenance needs it is suggested that one of the dispersion models be utilized in estimating future short term particulate concentrations.

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*Larsen, Ralph I., "A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards," USEPA, Publication No. AP-89.

CHAPTER IV

PROJECTED AIR QUALITY ANALYSES: SULFUR DIOXIDE

BACKGROUND

Maryland air pollution regulations for the control of sulfur dioxide emissions were designed to meet state secondary ambient air quality standards, as follows:

Annual arithmetic average	$39\ \mu g/m^3$
24-Hour average	$131\ \mu g/m^3$
1-Hour average	$262\ \mu g/m^3$

Because of the stringency of these standards (approximately one-half the NAAQS), very severe control measures were deemed necessary and were promulgated by the BAQC.

Essential to these measures was the requirement that on and after 1 July 1975 all residual fuel oils must contain 0.5 percent or less sulfur by weight. In view of the uncertainties of low sulfur fuel availability (as well as cost) and the low levels of SO_2 concentration measured by the West-Gaeke reference method, the BAQC was considering easing the 0.5 percent regulation. The recommended choice of action proposed by the BAQC was to postpone the effective date of the 0.5 percent sulfur requirement to 1980 pending analysis of the 1974-1975 heating season data.

In the context of maintenance plan development, the postponement would have no effect on the SO_2 emission inventory and resulting air quality from 1980 to 1985. Between 1975 and 1980, with postponement, total SO_2 emissions from power plants will still be significantly reduced from the 1973 emissions by reduction in generating capacity within the region. Furthermore, because maintenance of NAAQS rather than state standards was the issue in the Natural Resources Defense Council litigative action, this analysis was based on the federal ambient air standards and currently effective SO_2 control regulations.

AIR QUALITY

Tables 16 and 17 list air quality data for the years 1972 and 1973. As expected, the continuous flame photometric values are greater than those reported by the reference method, perhaps because of decay of the bubbler

Table 16. BALTIMORE AQMA SULFUR DIOXIDE CONCENTRATIONS FLAME PHOTOMETRIC METHOD ($\mu g/m^3$)

		1972		1973					
				Average by qtrs.					
Station location	Site code	AAM	Max. 24-hr	1	2	3	4	AAM	Max. 24-hr
Calvert and 22nd St.	210120018	24	131	59	13	14	36	31	183
Green and Lombard Street	210120019	22	79	54	16	17	33	30	210
Essex	210680001	46	131	52	33	40	87	53	187
Garrison	210140003	24	86	48	53	94	104	75	160
Goucher	211640001	29	79	57	47	39	35	45	183
Wimarco Avenue	210120012					29	30		160
Read Street	210120004					57	54		267
Robinson and Toone	210120010					38	66		240
Sun and Chesapeake	210120011					67	79		288

Table 17. BALTIMORE AQMA SULFUR DIOXIDE CONCENTRATIONS
24-HOUR BUBBLER METHOD
($\mu g/m^3$)

		1972		1973			
				Average by qtrs.			
Station location	Site code	AAM	Maximum	1	2	3	Maximum
Harmons	210080006	15	100	23	9	3	62
Harwood	210080008	6	26	20	5	4	46
Odenton	210080002	16	84	17	6	2	82
Johns Hopkins	210120020	37	121	43	33	10	104
Morgan	210120015	22	128	9	2	1	54
Poly	210120016	3	33	15	2	1	112
Catonsville	210140004	22	83	46	2	5	104
Cockeysville	210500001	8	62	6	0	0	20
Lansdowne	211040001	24	90	31	11	11	60
Middle River	210120021	2	26	8	3	3	80
Follens Point	210620001	29	86	40	25	11	106
Westminster	211720002	7	49	12	9	3	27
Bel Air	210180001	14	64	15	5	2	42
Whiteford	210920002	3	23	1	3	2	11
Ellicott City		29	71				
Calvert & 22nd St.	210120018					5	12
Simpsonville	210960003			6	3	2	12

concentrations before analysis. However, none of the NAAQS were exceeded, as determined by either method.

An additional air quality data set for a part of 1973 was available from the National Aerometric Data Bank. The 24-hour bubbler data was insignificantly different from the BAQC data. However, some of the flame photometric values were very much higher than those reported by the BAQC. For example, values for the last three days reported in September 1973 showed averages of 785, 862, and 940 $\mu g/m^3$, respectively, with hourly values never below [illegible]76. An analysis of weather conditions during that period indicated meteorological conditions not conducive to continued high values of point source dependent concentrations. In fact, a cold frontal passage (with attendant rain showers, wind shift, and increased visibility) occurred approximately midway through the period. It is, therefore, believed that these high values are in error, and consequently the BAQC data was used in the analysis.

BASELINE EMISSION INVENTORY

The 1973 emission inventory was obtained from the same source as that for particulate emissions (Section III). This inventory is summarized in Table 18.

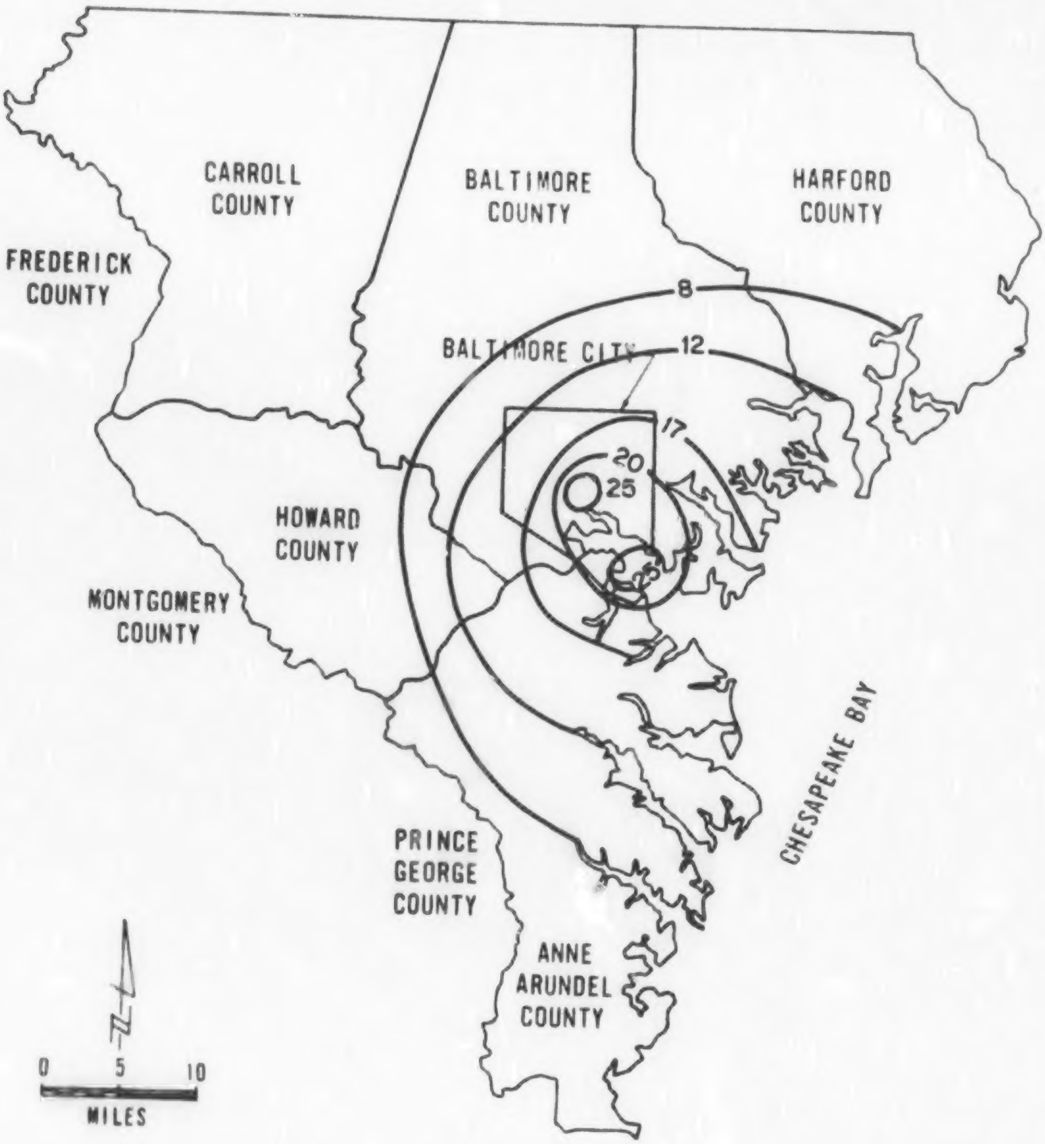
RELATING EMISSIONS TO AIR QUALITY USING AQDM

The 1973 air quality data and emission inventory were used in the AQDM model with the Briggs plume rise formula to compute the annual average concentration field. All area sources and those point sources with an emission rate of greater than 25 tons/day were considered (comprising approximately 85 percent of total emissions). The referenced method air quality data were used for calibration. The resulting regression line had a slope of 0.79, a y-intercept of 0.9, and a coefficient of 0.67. Figure 15 shows the results of the computer calculations.

An additional analysis by the AQDM was made considering only point sources greater than 25 tons per day. The results of that analysis are shown in Figure 16. A visual inspection of Figures 15 and 16 indicates that the maximum concentration from area sources alone would be approximately 18 $\mu g/m^3$ located near the city center.

Table 18. BALTIMORE AQMA SULFUR DIOXIDE EMISSIONS FOR 1973
(tons/year)

Fuel combustion - stationary sources	Anne Arundel County	Baltimore County	Carroll County	Harford County	Howard County	Baltimore City	Regional total
Residential	1,171	1,730	358	334	186	3,163	6,942
Commercial/institutional	1,259	2,058	453	365	122	3,566	7,823
Industrial	149	9,383	123	81	230	4,458	14,424
Power plants	43,611	18,341	0	393	0	9,107	71,452
Total stationary fuel combustion	46,190	31,512	934	1,173	538	20,294	100,641
Industrial process	91	28,911	41	103	1	10,560	39,707
Solid waste disposal	0	3	0	0	0	362	365
Transportation	4,917	2,429	123	186	109	1,926	9,690
Miscellaneous	0	0	0	0	0	0	0
Totals	51,198	62,855	1,098	1,462	648	33,142	150,403


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
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BALTIMORE CITY
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HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
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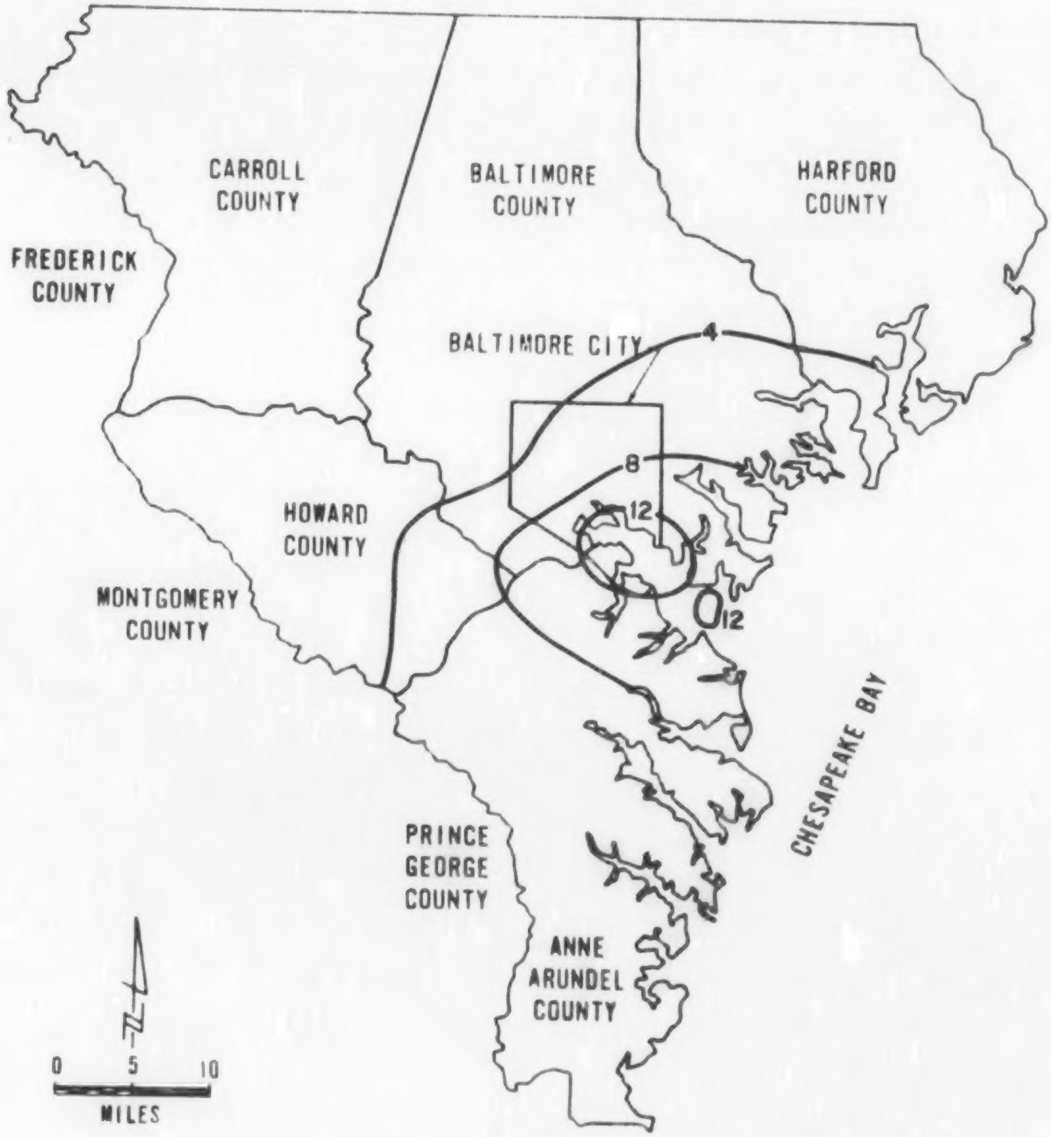
MILES

Figure 15. 1973 sulfur dioxide air quality from all sources in the Baltimore AQMA ($\mu g/m^3$)


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
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HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
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MILES

Figure 16. 1973 sulfur dioxide air quality from point sources in the Baltimore AQMA ($\mu g/m^3$)

PROJECTED EMISSION INVENTORY

The 1975, 1980, and 1985 projected emission inventories are presented in Table 19. Bases for the projections were as follows:

(1) Residential and commercial/institutional heating was based on a population growth rate of 1.52 percent per year. This estimate was conservative because of the decreasing percentage of oil heating for this source category. No coal heating starts were reported for 1973 and January to March 1974.

(2) Industrial heating was based on growth of manufacturing employment at the rate of 0.5 percent per year. Fuel split projections were:

	1973	1975	1980	1985
Light oil (M gal)	54,451	54,997	56,386	57,809
Heavy oil (M gal)	147,986	149,470	153,244	157,113
Natural gas (MM ft^3)	16,825	16,825	16,825	16,825

In 1975 light oil was limited to 0.3 percent sulfur by weight and heavy oil was limited to 0.5 percent sulfur by weight.

(3) Power plant emissions were based on growth rates presented in Appendix D, Figure D-2, and on the use of 0.5 percent sulfur fuel in 1975. The growth rates for power generation within the AQMA were:

1973 - 1975 :	-30.8% per year
1975 - 1980 :	+ 3.8% per year
1980 - 1985 :	+ 1.6% per year

The emission values derived by this method differed from those obtained by linear interpolation of Federal Power Commission (FPC) data. Interpolation from the 1978-1983 FPC projected SO_2 emissions indicated a five percent per year growth rate with the following total emissions:

1975 :	15,716 tons/year
1980 :	20,806 tons/year
1985 :	25,896 tons/year

Table 19. BALTIMORE AQMA SULFUR DIOXIDE EMISSIONS FOR FUTURE YEARS (tons/year)

	1973	1975	1980	1985
Fuel combustion				
Residential	6,942	7,155	7,715	8,320
Commercial/institutional	7,823	8,063	8,694	9,375
Industrial	14,424	7,038	7,216	7,398
Power plants	71,452	17,084	20,551	22,285
Total stationary fuel combustion	100,641	39,340	44,176	47,378
Industrial process	39,707	40,105	41,118	42,156
Solid waste disposal	365	172	172	172
Transportation	9,690	10,467	12,577	13,662
Totals	150,403	90,084	98,043	103,368

(4) Industrial process emissions were based on the 0.5 percent per year growth rate of manufacturing employment.

(5) Refuse disposal emissions were based on prohibition of open burning of solid waste and shut down of incinerators.

(6) Transportation growth was based on the growth rate of vehicle miles traveled (Appendix C).

PROJECTED AIR QUALITY

The analyses indicated that NAAQS will not be violated during the decade from 1975 to 1985. This conclusion was based on the following observations:

(1) The 1973 maximum annual average concentrations and 24-hour concentrations of sulfur dioxide as measured by the reference method were each less than one-half the primary standard;

(2) Maximum 3-hour concentrations, as measured by the flame photometric method, were much less than the secondary standard;

(3) The AQDM modeled results predicted low levels of annual concentrations; and

(4) The projected SO_2 emission inventory showed a net reduction of sulfur dioxide emissions of 35 percent by 1980 and 31 percent by 1985.

A new Brandon Shores power plant was the only significant new generating source expected in the area during the next decade. Because of its location near the presently operating Wagner plant, SO_2 plumes from the two sources conceivably might reinforce each other and produce higher concentrations than either alone. A comprehensive study by Johns Hopkins Applied Physics Laboratory* examined the concentrations which might be expected from these two power plants. It was concluded that no standards, either Federal or state, would be violated when both the Wagner and Brandon Shores facilities were operating.

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*Extended Analytic Air Quality Estimates. The Johns Hopkins University, Applied Physics Laboratory, Chesapeake Bay Institute Department of Geography and Environmental Engineering. Baltimore, Maryland. January 18, 1973. 32 p.

It is therefore concluded that no plan maintenance will be required for the Baltimore AQMA to maintain sulfur dioxide air quality levels below the national ambient air quality standards.

CHAPTER V

PROJECTED AIR QUALITY ANALYSES: OXIDANTS

BACKGROUND

On 12 December 1973 (38FR 34240) the Administrator of the EPA imposed upon the Metropolitan Baltimore Intrastate AQCR a transportation control plan (TCP) for the control of hydrocarbon emissions. Based on the 1972 hydrocarbon emission inventory and the resulting concentration level of photochemical oxidants and using the procedures in Appendix J of 40 CFR part 51, it was calculated that a 70 percent reduction in hydrocarbon emissions was required by 31 May 1977 in order to comply with the Clean Air Act. This reduction was to be achieved by the control measures listed in Table 20. A major part of the reduction (8.73 tons per peak period) was to be realized by the limitation of gasoline distribution. This measure was designed to reduce vehicle miles traveled (VMT) by 50 percent over and above the reduction effected by the other VMT measures, i.e., exclusive bus lanes, carpool locator, etc.

A transportation control plan proposed earlier by Maryland utilized a different transportation model and suggested different but similar control strategies. The Maryland analysis resulted in a requirement for 52 percent reduction in peak period traffic above that realized by the suggested strategies, a result surprisingly similar to EPA's 50 percent. The EPA plan did not suggest a method for obtaining the 50 percent reduction in VMT other than by gas rationing. On the other hand, the Maryland plan at one stage in development considered the possibility of VMT restriction during episodic situations and suggested a windshield sticker system for control. This approach was not approved by EPA for adoption as a control method.

A major reduction (3.38 tons per peak period) was to be obtained in the EPA plan by catalytic retrofit of 1971-1975 light and medium duty vehicles. It is doubtful if retrofit is a viable control measure in view of the current difficulties with new vehicle catalytic converters. Nevertheless, in this analysis it was assumed that all TCP measures, except gasoline distribution

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Table 20. COMPILATION OF HYDROCARBON CONTROL STRATEGY EFFECTS ON THE METROPOLITAN BALTIMORE INTRASTATE AIR QUALITY CONTROL REGION ON MAY 31,1977[(a)]

	Hydrocarbons	
	Tons per peak period[(b)]	Percent of base year
1972 emissions	61.0	100.0
Reduction required to reach NAAQS	42.7	70.0
Stationary sources		
Emissions without control strategy	13.5	22.1
Expected reduction from existing regulations:		
(1) Solvent control	0.85	1.4
(2) Gasoline handling vapor recovery (bulk)	1.0	1.6
(3) Drycleaning emissions control	0.39	0.6
(4) Aircraft ground operations	-0.18	-0.3
(5) Net result of industrial growth	-0.17	-0.3
Promulgated stationary source controls:		
(1) Control and prohibition of major sources	0.52	0.9
(2) Gasoline handling vapor recovery (stage 1)	0.57	0.9
(3) Gasoline handling vapor recovery (stage 2)	0.95	1.6
Stationary source emissions remaining	9.57	15.7
Mobile sources		
Emissions from LDV's, MDV's and HDV's without control strategy	47.5	77.9
Expected reductions:		
(1) Federal motor vehicle control programs	18.7	30.7
(2) Inspection and maintenance (LDV, MDV)	2.23	3.7
(3) VSAD retrofit, pre-1968 LDV's	0.29	0.5
(4) Air fuel retrofit, 1968-1971 LDV's	0.80	1.3
(5) Catalytic retrofit, 1971-1975 LDV, MDV	3.38	5.5
(6) Air fuel retrofit, pre-1974 MDV's	0.22	0.4
(7) Air fuel retrofit HDV's	1.38	2.3
(8) Traffic flow improvements	2.61	4.3
(9) VMT measures: exclusive bus lanes, car-pool locator, bikeway program, parking restrictions	0.43	0.7
(10) Gasoline distribution limitation	8.73	14.3
Mobile source emissions remaining	8.73	14.3
Total reductions	42.7	70.0
Total emission remaining	18.3	30.0
Total allowable emissions	18.3	30.0

(a) Source: 38 FR 34245

(b) Defined as the period from 6:00 to 9:00 a.m.

limitations, were fully implemented by 1977. This assumption concerning base line year data had diminishing effect over the decade as retrofit devices would be applied to fewer and fewer vehicles.

AIR QUALITY

The roll back requirements for which the TCP was designed were based on 1972 oxidant air quality data. 1973 data are now available. Both years are summarized as follows:

	Highest hourly average		Next highest hourly average	
Year	Location	Value (ppm)	Location	Value (ppm)
1972	Calvert & 22nd	0.21	Calvert & 22nd	0.21
1973	Essex	0.23	Essex	0.20

BASELINE EMISSION INVENTORY

The hydrocarbon emissions inventory upon which the TCP was based is given in Table 21 along with the estimated 1973 inventory. No change in non-automotive emissions is assumed. Automotive emissions are estimated using 2.26 percent growth in LDVMT, 5.84 percent growth in MHDVMT, and the appropriate changes in emission factors resulting from the Federal motor vehicle control program (FMVCP). The VMT growth factors are those used in the TCP and originated from traffic modeling by the BAQC.

The estimated 5.4 percent reduction in hydrocarbon emissions has resulted in an apparent 4.8 percent reduction in the second highest oxidant value. This reduction is not inconsistent with the value derived from the postulated relationship given in Appendix J of 40 CFR, part 51.

Table 21. BALTIMORE AQMA HYDROCARBON EMISSIONS FOR 1972 AND 1973 (tons/6:00-9:00 a.m.)

	Hydrocarbon emissions	
	1972(a)	1973
Total non-automotive	13.46	13.46
Light duty vehicles	35.13	31.62
Heavy/medium duty vehicles	12.39	12.61
Total automotive	47.52	44.23
Total	60.98	57.69

(a) Source: "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," Environmental Protection Agency, Region III, March 1974.

PROJECTED EMISSION INVENTORY - 1977

The 1977 projected emission inventory assumed full operation of all controls except gasoline distribution limitations, as promulgated in the TCP (Table 22). Important considerations in projecting the 1977 inventory from the 1972 inventory (Table 21) are itemized below:

(1) Assume a reduction in automotive emission factors by maintenance and inspection. A regulation which requires a dynamic mode inspection of all gasoline vehicles, when set at an initial failure rate of 30 percent, would result in a 13 percent reduction in hydrocarbon emissions.

(2) Assume a reduction of automotive emission factors by retrofit of emission control techniques as follows:

  (a) Vacuum spark advance disconnect, pre-1968 LDV-25 percent effective.

  (b) Air/fuel retrofit, 1968-1971 LDV - 25 percent effective.

  (c) Catalytic retrofit, 1971-1975 LDV - 50 percent effective.

  (d) Air/fuel retrofit pre-1974 MDV - 15 percent effective.

  (e) Catalytic retrofit 1971-1975 MDV - 50 percent effective.

  (f) Air/fuel retrofit HDV - 30 percent effective.

(3) Assume a decrease of 133,085 LDVMT during the period by carpooling and exclusive bus lanes.

(4) Assume traffic flow improvements resulting in higher speeds and reduced hydrocarbon emissions.

(5) Assume a 2.26 percent annual increase in LDVMT from 1972 with appropriate FMVCP factors.

(6) Assume a 5.84 percent increase in HMDVMT with appropriate FMVCP factors.

(7) Assume a regulation that requires major sources to not increase emissions and that prohibits new major sources.

Table 22. BALTIMORE AQMA HYDROCARBON EMISSIONS FOR FUTURE YEARS
(tons/6:00-9:00 a.m.)

	1977(a)	1980	1985
Gasoline storage and handling			
Bulk storage	0.85	0.90	0.94
Terminal loading	0.32	0.34	0.35
Service station pumps	0.06	0.06	0.07
Service station pumps	0.14	0.15	0.15
Subtotal	1.37	1.45	1.51
Power plants	0.64	0.37	0.40
Refuse	0.10	0.10	0.10
Diesel and shipping	1.20	1.23	1.35
Industrial processing heat	0.79	0.80	0.82
Dry cleaning (reactive HC)	0.07	0.00	0.00
Other solvents	3.88	3.94	4.04
Miscellaneous gasoline engines	0.33	0.40	0.43
Aircraft	1.10	1.23	1.49
Total non-automotive	9.53	9.52	10.14
Light duty vehicles (Table 26)	8.70	5.99	4.10
Heavy/medium duty vehicles (Table 26)	8.76	9.54	10.11
Total automotive	17.46	15.53	14.21
Total	26.99	25.05	24.35

(a) Source: "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," Environmental Protection Agency, Region III, March 1974.

(8) Assume use of gasoline handling vapor recovery system at service stations for truck to storage tank emission control (Stage 1) and for pump to automobile tank emission control (Stage 2).

(9) Assume total conversion to non-reactive fluids in dry cleaning establishments.

The EPA transportation control plan was based on a transportation model developed for the BAQC. This adaptation of the well-known Koppelman model generates trip end data by interpolating 1962 and 1980 forecast trip ends and approximating VMT and average speeds by district. The traffic model has been expanded to accept emission factors including those for running emissions and trip end emissions, cold start, and hot soak. More sophisticated modeling techniques have been developed by both the BAQC and the Maryland DOT which have been used in other studies. The MDOT model was described earlier in Chapter II of this report. The data given in Appendix C were derived from this model and used to project 1977 base line year data to 1980 and 1985. A comprehensive report, "Baltimore Regional Environmental Impact Study (BREIS)," by the MDOT used the model to predict automotive emissions to 1980 and 1995. Results were very similar to the results reported herein, although the conclusions reached were different.

In order that this analysis would be consistent with the TCP promulgated by EPA, the 1972 and 1977 emission inventories were based on the BAQC data and emission factors reported by EPA. These factors were calculated without regard to speed or trip end emissions. Table 23 summarizes the transportation information which was utilized to predict the 1977 emissions.

Table 23. BASELINE TRANSPORTATION DATA USED TO PREDICT 1977 HYDROCARBON EMISSIONS

	1972			1977		
	LDV	HDV	Diesel	LDV	HDV	Diesel
VMT peak period (1000s)(a)	3,892	476	58	4,352	632	76
HC emissions (tons/peak period)(a)	35.13	12.39	0.21	8.70	8.76	0.28
Emission factor (g/mile)(b)	8.19	23.61	3.29	1.81	12.57	3.34

(a) Source: "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," Environmental Protection Agency, Region III, March; Maryland Amendment to SIP, June 15, 1973; and Tables 21 and 22.

(b) $\text{EF (g/mile)} = \frac{\text{HC emissions (tons)}}{\text{VMT (mile)}} \times \frac{2{,}000 \text{ lbs}}{\text{tons}} \times \frac{453.59 \text{ g}}{\text{lbs}}$

PROJECTED EMISSION INVENTORY - 1985

The 1980 and 1985 projected emission inventories are presented in Table 22 along with the 1977 predictions. The bases for non-automotive emission projections, in addition to those specified in the TCP, were as follows:

(1) Gasoline storage and handling growth rates were projected at one half the growth rate of VMT as shown in Appendix C:

Thousands

VMT 1977 = 3,255.90
VMT 1980 = 3,622.04 Growth rate = 3.62 percent per year
VMT 1985 = 3,943.65 Growth rate = 1.72 percent per year

This projection assumed the continuation of the present trend toward smaller cars and increased gasoline mileage.

(2) Power plant emissions would decrease because of the decrease in generating capacity within the AQMA (Appendix D).

(3) No change was projected in hydrocarbon emissions from refuse disposal because of the ban on open burning and control of incinerators.

(4) Diesel and shipping included, for 1977, 0.28 tons per peak period for diesel highway vehicles and 0.92 for other diesel sources. Diesel highway vehicle emissions were projected at 1.1 times the growth rate in VMT as shown in Appendix C to reflect increased city bus service. Other sources were projected at the growth rate of transportation employment, 1.2 percent per year.

(5) Growth in industrial process heating was based on growth of manufacturing employment, 0.5 percent per year.

(6) A reduction in dry cleaning establishment emissions resulted from the regulation prohibiting use of reactive solvents.

(7) Emissions from other solvent uses were projected on the basis of growth in manufacturing employment.

(8) Miscellaneous gasoline engines were projected to grow at the same rate as population, 1.52 percent per year.

(9) Aircraft operations would grow at a rate of 7.7 percent per year(*). Emissions from aircraft were projected to grow at half this rate because of the introduction of bigger and cleaner engines.

The 1985 automotive emission factors were calculated using methods given by Kircher and Armstrong(+) (Table 24). Appendix A contains the detailed calculations. Emission factors shown in Table 24 reflect the FMVCP and appropriate deterioration factors in accordance with vehicle age. VMT growth factors, from the 1977 base line year, were obtained from data provided by the Baltimore Metropolitan Area Region Planning Council (Appendix B). Appendix C contains the calculations of HC emissions derived from the data presented in Appendices A and B.

Table 25 shows the 1977, 1980, and 1985 HC emissions from mobile sources as projected considering only increase in VMT, speed factors, and application of the FMVCP with deterioration factors. TCP mandated control measures were not included.

The rather circumlocutory method for projecting automotive emissions shown in Table 25 was necessitated for the following reasons:

(1) The 1977 base line year inventory was derived from a different transportation model than was Appendix C data.

(2) The definition of LDV and HDV was different for the two data sets.

(3) Diesel engine-powered vehicles were included in the Appendix C VMT.

(4) Different factors for calculating peak hour VMT.

These shortcomings were considered to be overcome by using Appendix C data as derived from the MDOT model only for growth factors and not for absolute values.

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* Aircraft Emissions: Impact on Air Quality and Feasibility of Control, EPA, undated.

+ "An Interim Report on Motor Vehicle Emission Vehicle Mix and Mileage," from "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," EPA, 1974.

Table 24. MOBILE SOURCE EMISSION FACTORS[(a)]
(g/mile)
(Without speed correction or retrofit)

Year	Light duty vehicles		Heavy duty vehicles	
	NO_x	HC	NO_x	HC
1972	4.484	8.026	9.321	23.643
1975	3.664	5.150	9.259	20.601
1977	2.638	3.153	9.230	18.753
1980	1.500	1.622	9.214	17.198
1985	0.727	0.815	9.200	16.183

(a) Emission coefficients from "An Interim Report on Motor Vehicle Emission Vehicle Mix & Mileage" from "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," EPA, 1974.

Table 25. PROJECTED HYDROCARBON EMISSIONS FOR GASOLINE AUTOMOBILE VEHICLES WITHOUT CONSIDERING THE TCP CONTROL MEASURES
(tons/peak period)

Year	TCP[(a)]			Appendix C			Projected[(b)]		
	LDV	HDV	Total	LDV	HDV	Total	LDV	HDV	Total
1977	15.49	13.05	28.54	10.04	11.78	21.82	15.49	13.05	28.54
1980				5.58	11.74	17.32	8.61	13.01	21.62
1985				3.04	12.09	15.13	4.69	13.39	18.08

(a) Source: "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," Environmental Protection Agency, Region III, March 1974. Total emissions can be calculated from Table 20 and the preceeding discussion:

$$\begin{aligned}\text{Total Emissions} &= (\text{Emissions without control strategies}) - (\text{reductions from FMVCP}) - (\text{diesel highway emissions}) \\ &= 47.5 - 18.7 - 0.28 \\ &= 28.52\end{aligned}$$

(b) $$\text{Projected emission }(i,j) = \frac{\text{Appendix C Emission }(i,j)}{\text{Appendix C Emission, 1977}} \times \text{TCP Emissions}_{1977}$$

i = LDV or HDV j = 1980 or 1985

For example, $LDV_{1980} = \frac{5.58}{10.04} \times 15.49 = 8.61$

Certain of the control strategies mandated in the TCP were applicable, in part, to 1980 and 1985 automotive emissions. These were summarized in Table 26 along with the expected reductions from each strategy. When these reductions were applied the final projected emission inventory was complete.

Base line peak hour VMT may be projected in the same way as peak hour emissions. These and the resulting emission factors for 1980 and 1985 are shown in Table 27.

Table 26. PROJECTED 1980 AND 1985 EMISSION INVENTORY (tons/peak period)

	1980	1985
Stationary sources (Table 22)	9.52	10.14
Automotive sources (Table 24)	21.62	18.08
Total	31.14	28.22
Allowed (Table 20)	18.30	18.30
Reduction required	12.84	9.92
Reductions mandated		
(1) Inspection and maintenance	2.18	1.80
(2) VSAD retrofit, pre-1968 LDV's	0.09	0.00
(3) Air fuel retrofit, 1968-1971 LDV's	0.24	0.00
(4) Catalytic retrofit, 1971-1975 LDV/MDV	1.94	0.33
(5) Air fuel retrofit, MDV	0.10	0.03
(6) Air fuel retrofit, HDV	1.54	1.71
(7) Traffic flow improvements	0.00(a)	0.00(a)
(8) VMT measures	0.00(a)	0.00(a)
Total reductions	6.09	3.87
Reductions remaining	6.75	6.05

(a) No reductions warranted since the 1980/85 transportation projections should include mandated traffic flow and VMT measures.

Table 27. PROJECTED VMT (1000's) AND EMISSION FACTOR (g/mile) FOR 1980 AND 1985 PEAK PERIODS

Year	Table 23		Appendix C		Projected	
	LDV	HDV	LDV	HDV	LDV	HDV
1977	4352	632	3256	643	4352	632
1980			3622	715	4841	703
1985			3944	795	5272	781

Emission Factor (g/mile)

Year	LDV			HDV		
	Exhaust	Evaporative	Total	Exhaust	Evaporative	Total
1977	1.104	0.710	1.814	8.452	4.122	12.574
1980	0.824	0.298	1.122	8.833	3.478	12.311
1985	0.506	0.200	0.706	8.743	3.000	11.743

$$\text{Emission Factor} = \frac{\text{Total Emissions (Table 22)}}{\text{Total Miles (Table 27)}}$$

IMPLICATIONS OF THE ANALYSIS

Table 28 presents a recapitulation of the derived data in the preceding section. Figure 17 is a display of the relative importance of the several source categories. The increasing importance of emissions from trucks is readily apparent. This importance can be demonstrated graphically with the use of two linear equations which define the allowable emissions to meet the standards:

$$EF_{LDV}(\text{LDVMT}) + EF_{HDV}\ (\text{HDVMT}) + NA = 18.3 \text{ tons/peak period}$$

where

EF is the emission factor for the two classes (tons/mile) and LDVMT and HDVMT are the 6:00-9:00 a.m. vehicle miles traveled for the two classes and, NA is the total non-automotive sources. The allowable emissions are 18.3 tons/peak period.

$$1980\text{:}\quad 1.122\ (\text{LDVMT}) + 12.311\ (\text{HDVMT}) = 7.97 \times 10^6$$

$$1985\text{:}\quad 0.706\ (\text{LDVMT}) + 11.743\ (\text{HDVMT}) = 7.40 \times 10^6$$

Table 28. SUMMARY OF DERIVED DATA RELATING TO HYDROCARBON EMISSIONS FROM MOBILE SOURCES

	1977		1980		1985	
	LDV	HDV	LDV	HDV	LDV	HDV
Automotive emission factors (g/mile)						
FMVCP plus deterioration	3.153	18.753	1.622	17.198	0.815	16.183
with speed factors and control measures	1.814	12.574	1.122	12.311	0.706	11.743
VMT (1,000's/peak period)	4,352	632	4,841	703	5,272	781
Emissions (tons/peak period)	8.70	8.76	5.99	9.54	4.10	10.11
Total automotive	17.46		15.53		14.21	
Total non-automotive	9.53		9.52		10.14	
Total	26.99		25.05		24.35	
Total allowed (tons/peak period)			18.30		18.30	
Reduction required (tons/peak period)			6.75		6.05	
Reduction required (%)			27		25	

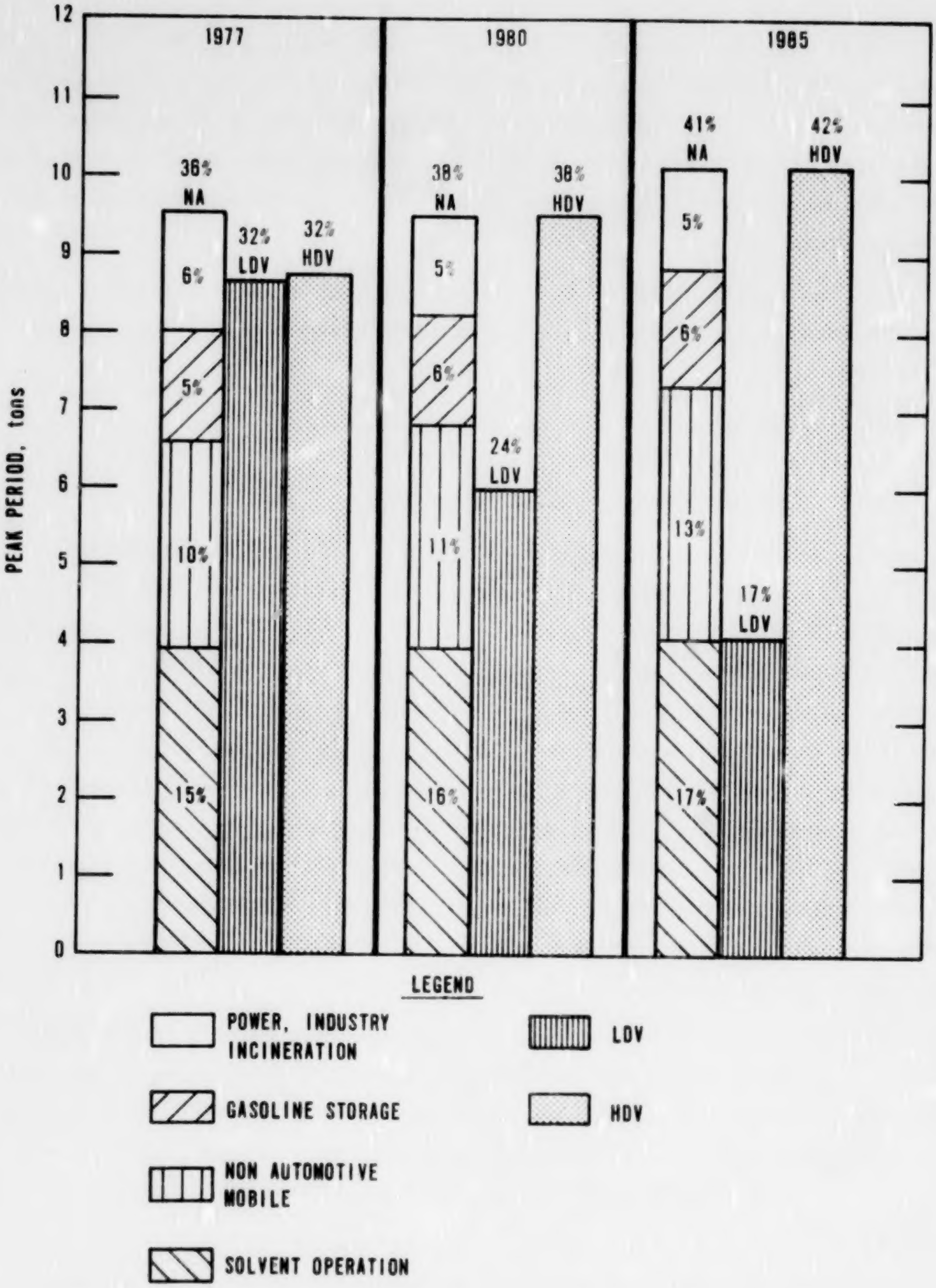

Figure 17. Baltimore AQMA hydrocarbon emissions for for future years by source category

These two lines are plotted in Figure 18 together with the 1977 equation. Using the VMT projections from Tables 23 and 27, plotted on the figure, it is observed that, as projected, the VMT points do not converge to the appropriate line. This indicates continued large gasoline distribution limitations without reductions in VMT or further control of non-automotive sources.

This can be further illustrated by additional equations which describe the percent reduction required in the two VMT classes to meet standards, as follows:

1977: 7.89 (LDVMT%R) + 7.94 (HDVMT%R) = 788

1980: 5.43 (LDVMT%R) + 8.65 (HDVMT%R) = 612

1985: 3.72 (LDVMT%R) + 9.17 (HDVMT%R) = 549

These equations are plotted in Figure 19. As can be observed for 1977, a 100 percent reduction is required in either LDVT or HDVT (or 50 percent in both or stated in the TCP); by 1980 either 103 percent in LDVMT or 71 percent in HDVMT or 43 percent in both; by 1985, 148 percent in LDVMT or 60 percent in HDVMT or 42 percent in both. Of course, rather than reducing VMT by these amounts, emissions might be reduced a corresponding amount. This illustrates the impossibility of meeting standards by control of LDVMT or increasingly stringent exhaust pipe devices. On the other hand, 60 percent reduction in HDVMT might be possible and certainly exhaust system controls are feasible. If the 60 percent reduction were made here, the emission factor would be approximately 4.7 g/mile a reduction of nearly 80 percent over 1961 pre-controlled vehicles.

The projections of non-automotive sources is optimistic and depends upon strict adherence to the regulation prohibiting new sources. Any new refinery operations or gasoline storage and handling facility will have a marked negative effect. For instance, one 100 ton per year source is equivalent, in 1985, to 44,000 LDVMT during the 6:00-9:00 a.m. peak period or 2,600 HDVMT.

Figure 20 demonstrates the relative distribution of emission sources for hydrocarbons upon which the maintenance measures were based. A 25 percent reduction of hydrocarbon emissions is required to meet the NAAQS for oxidants of 0.08 ppm in 1985, but a 27 percent reduction of hydrocarbon emissions is required to meet the NAAQS in 1980.

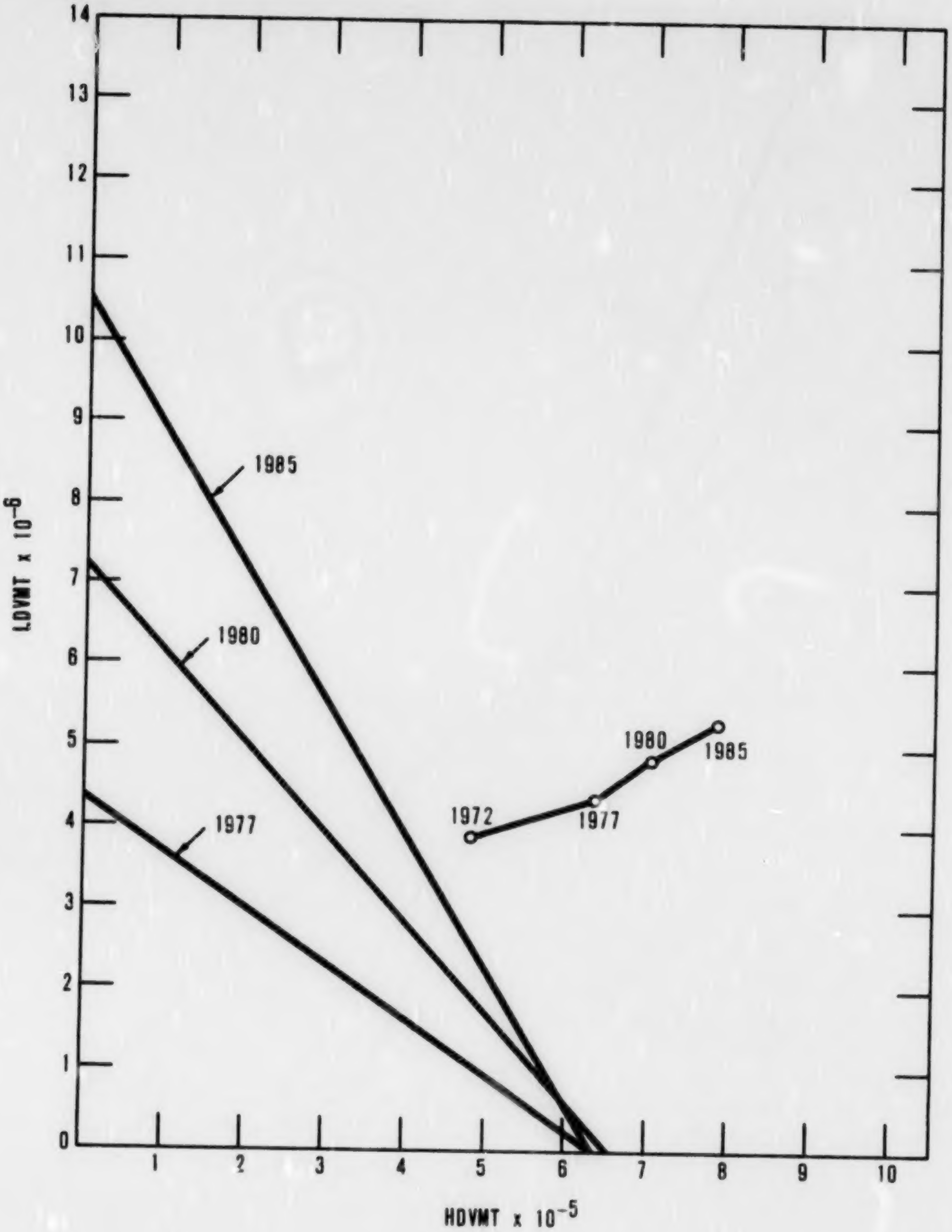

Figure 18. Allowed VMT to meet standards

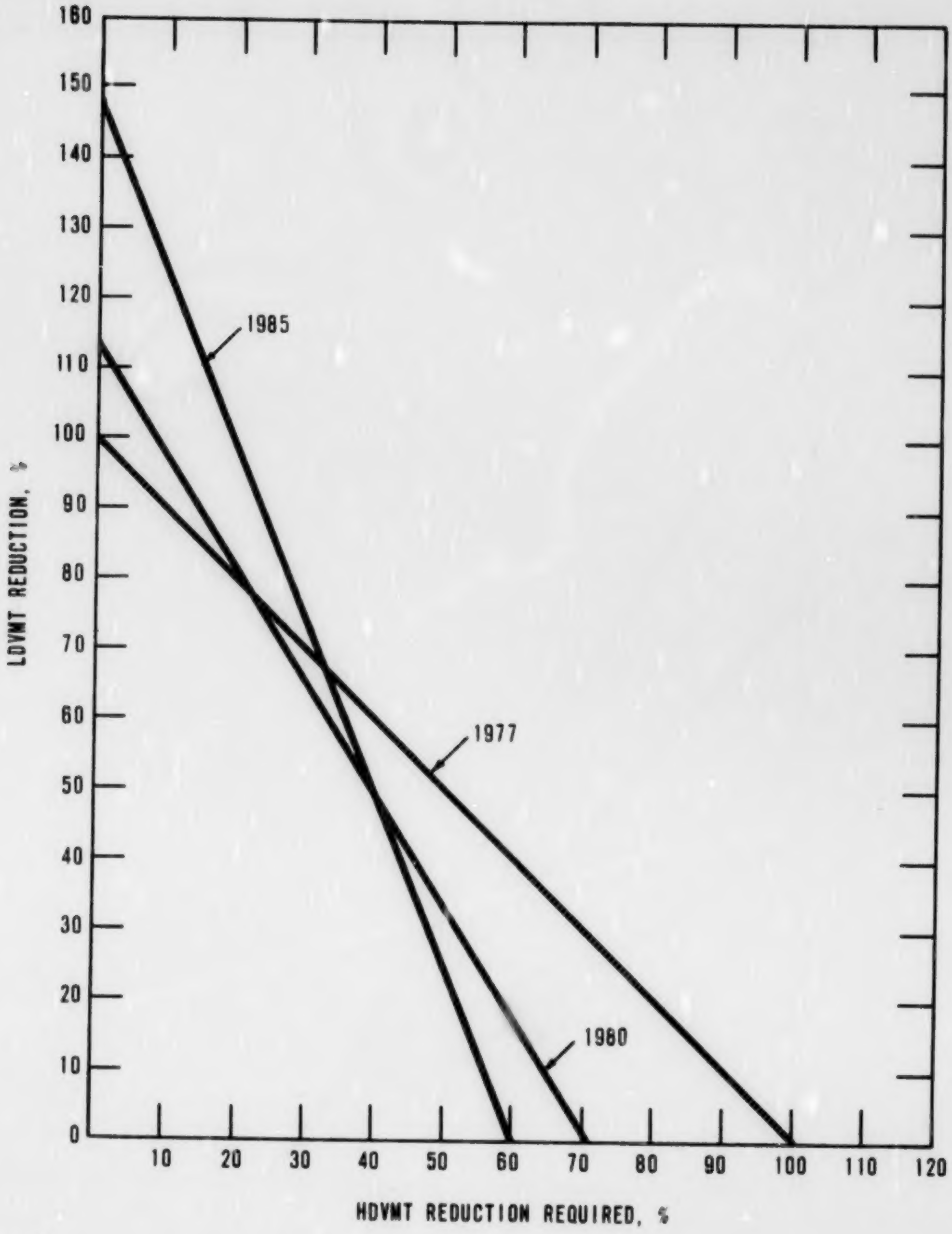

Figure 19. Automotive emission reductions required to meet standards

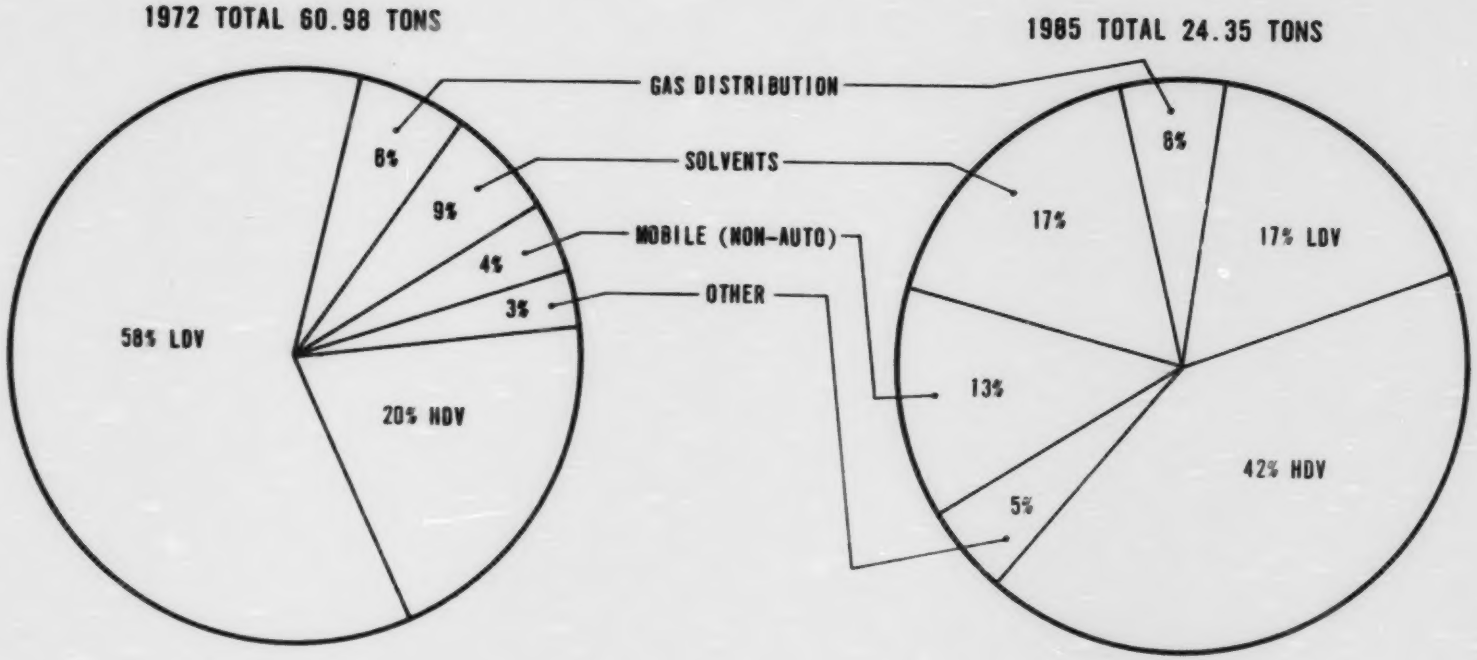

Figure 20. Distribution of hydrocarbon emissions by source category (tons/6-9 am)

CHAPTER VI

PROJECTED AIR QUALITY ANALYSES: NITROGEN DIOXIDE

BACKGROUND

The Maryland SIP for attainment of NAAQS in the Metropolitan Baltimore Intrastate Air Quality Control Region (Area III) was disapproved at 40 CFR Section 52.1075 because the plan did not provide for the degree of reduction of nitrogen oxide emissions that was attainable through the application of reasonably available control technology. An attainment date for the NO_2 NAAQS of July 1975 was imposed upon the State. Maryland air pollution control regulations were then amended to include the degree of control of NO_X emissions mentioned in the EPA Administrator's action disapproving the original SIP*.

Later, Section 52.1075 was revoked; Area III was reclassified from Priority I to Priority III for NO_2 and the region was declared to be in compliance with NAAQS for this pollutant. This action resulted from the investigation of the reference method for the measurement of NO_2 as reported in FR 38 15176, dated 8 June 1973.

AIR QUALITY

The Maryland BAQC inaugurated an NO_2 monitoring program in early 1972 which used the continuous Saltzman method of analysis, one of the candidate reference methods proposed by EPA for NO_2. Latest results from this monitoring program, as listed in Table 29, show the region to be in violation of NAAQS.

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* Maryland State Department of Health and Mental Hygiene. Rules and Regulations Governing the Control of Air Pollution in Area III, Sec. 10.03.38. Baltimore, Maryland. Secretary of the Maryland State Department of Health and Mental Hygiene. 43 p.

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Table 29. BALTIMORE AQMA NITROGEN DIOXIDE CONCENTRATIONS ($\mu g/m^3$)

Station	Site code	1972	1973			Annual
		4	1	2	3	average
Calvert and 22nd Street	210120018	143	141	87	97	117
Green and Lombard Street	210120019	94	109	85	97	96

Based on roll-back techniques the required emission reduction should equal 15 percent to meet the 100 $\mu g/m^3$ standard:

$$\frac{117-100}{117} \quad X \quad 100 \quad = \quad 15 \text{ percent}$$

EMISSION INVENTORY

The emission inventory for baseline year 1973 and projections to 1985 are presented in Table 30. The bases for the projections were, in general, the same as for hydrocarbon emissions; briefly, they were:

(1) Power plant projections in accordance with Appendix D.

(2) Decrease of refuse by 1975, with no later growth due to the ban on open burning and control of incinerators.

(3) Increase in residential/commercial heating and small gasoline engines at the population growth rate, 1.52 percent per year.

(4) Increase in diesel and shipping at the rate of 1.5 percent per year.

(5) Increase in aircraft at 7.7 percent per year.

(6) Increase in industrial heating and processing at 0.5 percent per year.

(7) Automobile emissions were estimated using the emission factors in Table 24 and the speed and growth factors from Appendices B and C. Certain of the EPA controls mandated for hydrocarbons will have a beneficial effect on NO_X emissions, particularly in

Table 30. BALTIMORE AQMA NITROGEN OXIDE EMISSIONS FOR FUTURE YEARS (tons/year)

	1973(1)	1975	1980	1985
Power plants	43,200	24,700	21,000	22,700
Refuse	400	300	300	300
Residential/commercial heating	12,500	12,900	13,900	15,000
Diesel and shipping	27,800	28,600	30,800	33,200
Aircraft	1,300	1,500	2,200	3,200
Industrial heating	17,900	18,100	18,500	19,000
Industrial process	35,800	36,200	37,100	38,000
Automotive	48,900	45,500	29,100	24,100
Miscellaneous gasoline	400	400	400	500
Total	188,200	168,200	153,300	156,000

(1) Designation of State Air Quality Maintenance Areas, Maryland BAQC, May 1974.

1980. By 1985 the retrofit measures will have little effect on total emissions, but the inspection and maintenance measure might provide some additional benefit.

A yearly maximum total of 160,000 tons emissions is required to maintain the standards as determined from the proportional model. Although the projected 1975 NO_X emissions are shown to exceed the 160,000 tons, the standards will be met in both 1980 and 1985. Reductions in VMT suggested in the oxidant control measures and the catalytic converter retrofit of LDV would result in further reductions.

PROJECTED AIR QUALITY

The analysis shows that NAAQS will be achieved between 1975-1980 and that the Standards will not be violated during the decade following attainment. It is recommended that no AQMA plan be required for NO_X emissions for the Baltimore area.

CHAPTER VII

METHODOLOGY FOR STRATEGY DEVELOPMENT

INTRODUCTION

It was determined that air quality maintenance plans were required for the control and distribution of particulate and hydrocarbon emissions. In the case of hydrocarbons this amounted to a 25 percent reduction in projected 1985 emissions and a 27 percent reduction in projected 1980 emissions, and in the case of particulates an improvement in air quality of 20 $\mu g/m^3$. Furthermore, the review of air pollution control regulations currently mandated by the State and the EPA indicated the very stringent control already in effect.

This information quickly led to the conclusion that heroic measures would be required to meet the air quality standards during the decade 1975 to 1985. It would be necessary to consider every conceivable additional control measure and to study in depth all the options available for input into the air quality maintenance strategy and plan development. This required a systemized conceptual approach that went far beyond that required in the usual state implementation plan. One such conceptual approach is provided by the "Residual Environmental Quality Management" (REQM)* framework and will be discussed in this chapter.

RESIDUALS - ENVIRONMENTAL QUALITY MANAGEMENT

Residuals-environmental quality management provides a framework for the systematic analysis of the range of options available for responding to air quality maintanance requirements. Inherent within this framework is the

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*The adaptation of the REQM framework to the air quality maintenance problem was conceived and developed by the Regional Environmental Management Program, Washington Environmental Research Center, Office of Research and Development, U.S.E.P.A., under the program management of Charles N. Ehler. Much of the material in this section was taken from working notes and papers perpared by him and his colleagues.

The original work on the REQM approach was performed by the Quality of the Environment Program, Resources for the Future, Washington, D.C., under the direction of Allen V. Kneese and Blair T. Bower.

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concept that all production and use activities of society result in the generation and discharge of some material and energy residuals, and that the weight of residuals discharged to the air, water, or land is approximately equal to the weight of the raw materials entering various production processes (plus the weight of oxygen added from the atmosphere during production) less the weight of the product produced. By examining regional production processes it becomes possible to identify numerous points where control measures may be applied, including final demand modification, changes in the spatial distribution of activities, raw material and energy input changes, residuals modification, storage and recycling, and others. Employing a consistent conceptual approach to air quality maintenance, allows for the possible analysis of all the variables of regional air quality and the consideration of a wide range of control measures, enabling the designated agency to make explicit the assumptions it has made due to limitations of resources.

The following definitions and assumptions are helpful.

(1) Residuals: material (solid, liquid and gases) and energy (light, heat, noise, etc.) outputs from production processes (industrial, agriculture, transportation, etc.) which have no economic value in existing markets or have a value less than their variable costs of production or use. These no-value or low-value materials and energy flows tend to be discharged into the various environmental media (land, air, and water) for "final" disposal, usually at little or no cost to the discharger, rather than being recovered, recycled or reused as an input to other production processes.

(2) Control Measure: a specified action which results in a change of the quantity, type, timing, or spatial location of residuals discharged into the ambient environment. Control measures can be categorized in the following way:*

A. Measures For Reducing The Discharge of Residuals

(i) Measures for reducing residuals generation
    (a) Change raw material inputs
    (b) Change production processes

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*Modified from Bower, Blair T. and Basta, Daniel J. Residuals-Environmental Quality Management: Applying the Concept, Baltimore, Maryland: Johns Hopkins Center for Metropolitan Planning and Research, October 1973, p. 12.

    - (c) Change mix of product outputs
    - (d) Change product output specifications
  - (ii) Measures for modifying residuals after generation
    - (a) Materials or energy recovery (direct recycle)
    - (b) By-product production (indirect recycle)
    - (c) Residuals treatment (without recovery--for reuse--of any material or energy)

B. Measures Directly Involving Environmental Assimilative Capacity

  - (i) Measures for making better use of assimilative capacity
    - (a) Emissions redistribution over space and/or over time
    - (b) Change the time scheduling of activities
    - (c) Change the spatial location of activities
  - (ii) Measures for increasing the assimilative capacity
    - (a) Modify atmospheric conditions
    - (b) Modify topographical conditions.

(3) Policy Instrument: a mechanism to achieve a specified control measure by either requiring the adoption of a specific control measure (e.e., requiring a scrubber) or by allowing the activity several options as to the control measures it selects (as when an emissions tax is applied). For any given control measure there are often several policy instruments available for their implementation. Policy instruments include economic incentives, subsidies, grants, emission taxes, standards setting, zoning, capital improvement programs, emissions limitations, performance or product specifications, compliance schedules, and so on. For example, a change in the raw material input (fuel) to a power plant (a specified control measure) could be achieved by writing and enforcing a specification (a policy instrument) on the sulphur content of the fuel used in energy conversion. Similarly, a change in the spatial location of activities (a specified control measure)--for example, heavy industry--can be achieved through zoning modifications (a policy instrument).

(4) Evaluation Criteria: the list of considerations which will permit the value judgement of the preferable set of measures. Not only must the selected set result in the required effectiveness but it must

be acceptable to the policy and decision making bodies. This infers, of course, that the measures must each be finally acceptable to the public.

(5) Institutions: the arrangement and relationships of organizations, both public and private, whose actions through specified policies can affect ambient environmental quality. Public institutions include all levels of government (Federal, state, regional, and local) as well as functions of government (legislative, administrative, judicial, etc.).

(6) Strategy: set of control measures, related policy instruments, and designated institutions selected to achieve a specified level of environmental quality.

The linkages between the competent parts of the REQM system are shown in Figure 21. The REQM framework assumes that control measures may be applied at each step in the generation of each gaseous residual for each source category. Some examples of measures for the reduction of particulate residuals from power plants under each class are listed below:

(1) Reduce final demand for power
    (a) Convert from incandescent to fluorescent lighting
    (b) Require better insulation

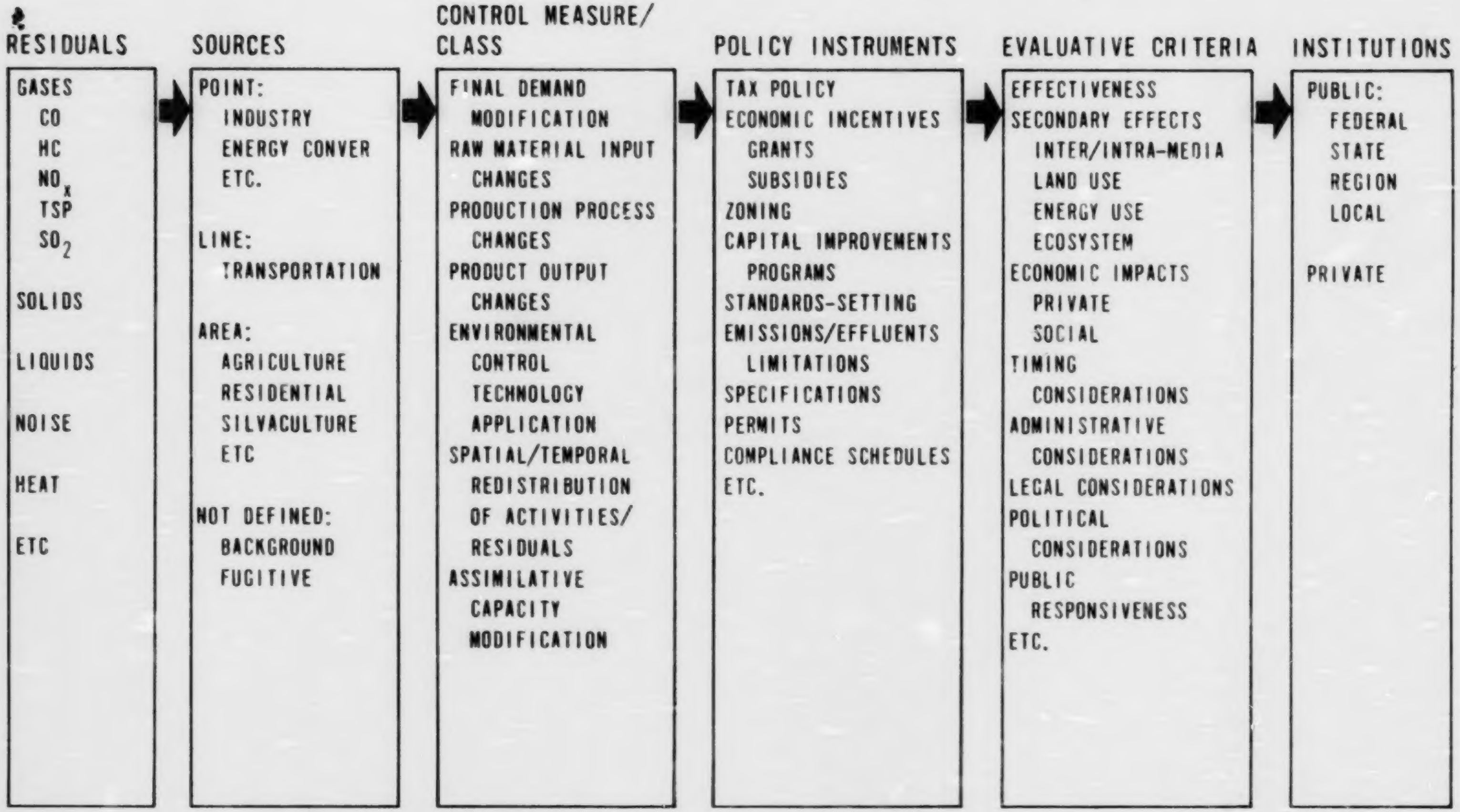
(2) Change raw material input
    (a) Reduce ash content of coal
    (b) Switch to gaseous fuel

(3) Change production process
    (a) Convert to nuclear power generation
    (b) Convert to solar power

(4) Change product output
    (a) Increase voltage

(5) Decrease environmental discharge
    (a) Improve control technology
    (b) Add more control devices

(6) Improve assimilative capacity
    (a) Increase wind speed


RESIDUALS
GASES
CO
HC
NO_x
TSP
SO_2
SOLIDS
LIQUIDS
NOISE
HEAT
ETC
SOURCES
POINT:
INDUSTRY
ENERGY CONVER
ETC.
LINE:
TRANSPORTATION
AREA:
AGRICULTURE
RESIDENTIAL
SILVACULTURE
ETC
NOT DEFINED:
BACKGROUND
FUGITIVE
CONTROL MEASURE/ CLASS
FINAL DEMAND MODIFICATION
RAW MATERIAL INPUT CHANGES
PRODUCTION PROCESS CHANGES
PRODUCT OUTPUT CHANGES
ENVIRONMENTAL CONTROL TECHNOLOGY APPLICATION
SPATIAL/TEMPORAL REDISTRIBUTION OF ACTIVITIES/ RESIDUALS
ASSIMILATIVE CAPACITY MODIFICATION
POLICY INSTRUMENTS
TAX POLICY
ECONOMIC INCENTIVES
GRANTS
SUBSIDIES
ZONING
CAPITAL IMPROVEMENTS PROGRAMS
STANDARDS-SETTING
EMISSIONS/EFFLUENTS LIMITATIONS
SPECIFICATIONS
PERMITS
COMPLIANCE SCHEDULES
ETC.
EVALUATIVE CRITERIA
EFFECTIVENESS
SECONDARY EFFECTS
INTER/INTRA-MEDIA
LAND USE
ENERGY USE
ECOSYSTEM
ECONOMIC IMPACTS
PRIVATE
SOCIAL
TIMING CONSIDERATIONS
ADMINISTRATIVE CONSIDERATIONS
LEGAL CONSIDERATIONS
POLITICAL CONSIDERATIONS
PUBLIC RESPONSIVENESS
ETC.
INSTITUTIONS
PUBLIC:
FEDERAL
STATE
REGION
LOCAL
PRIVATE

Source: Washington Environmental Research Center

Figure 21. Residuals environmental management linkages

(7) Alter spatial/temporal distribution
    (a) Utilize peak shaving/storage
    (b) Require high stacks

For each measure listed, the environmental and socioeconomic effects are estimated and catalogued. Examples of considerations used for the evaluation of individual control measures include:

(1) Environmental Impacts
    (a) Intra-media effects, e.g., do control measures for CO affect the discharge of TSP?
    (b) Resultant time and spatial patterns of air emissions generated and discharged due to AQM strategy
    (c) Time and spatial pattern of ambient air quality
    (d) Inter-media effects, e.g., do control measures for more solid waste for land disposal?
    (e) Energy use implications of AQM strategies
    (f) Land use implications of AQM strategies
(2) Economic Impacts
    (a) Direct impacts on the operating costs of air pollutant dischargers, e.g., private industry, municipal incinerators, public utilities, etc.
    (b) Direct benefits of the AQM strategy, e.g., the reduction in damages
    (c) Indirect impacts on income distribution, interregional production location decisions, and so on
    (d) The distribution of the costs of the AQM strategy, i.e., who pays?
    (e) The distribution of the benefits of the AQM strategy
(3) Timing Considerations
    (a) Time required to implement individual control measures of the AQM strategy
    (b) Time required to obtain first benefits from the AQM strategy
(4) Administrative Impacts
    (a) Costs of administering the AQM strategy, including manpower, facilities, monitoring instrumentation, etc.

(b) Simplicity of administration, i.e., the ease with which the rules and procedures required by the control measures could be implemented

(c) Flexibility of the AQM strategy, i.e., ability to respond and adapt to changing conditions and/or objectives over time

(5) Legal Considerations

(a) Legal constraints, i.e., the extent to which existing legislation would have to be changed to enable implementation of the AQM strategy

(6) Political Considerations

(a) Policy makers' perceived urgency of the air quality maintenance problem in terms of the views of their different constituents

(b) Policy makers' perceived urgency of the air quality maintenance problem relative to other problems of society, e.g., housing, transportation, regional economic development, and so on

(c) Policy makers' perceived impact of the AQM strategy on various political groups

(d) Impacts of the AQM strategy on inter-governmental relations, i.e., Federal-state, Federal-local, state-local, and so on

(e) Impact upon relations of air quality control agencies with other planning and management agencies, e.g., land use, transportation, and so on

(f) Potential conflict with existing policies and regulations, e.g., land use policies, capital improvement programs, taxation policies, etc.

(7) Public Acceptance/Responsiveness

(a) Extent of public's participation in the objective-setting, plan preparation, and plan evaluation process

(b) Public's perception of the adequacy of the AQM strategy to adequately deal with the AQM problem

(c) Extent of coincidence of the proposed AQM strategy with the values of the public regarding such issues as equity and efficiency

(d) Public's acceptance of the proposed strategy, e.g., gas rationing, parking surcharges, etc.

Essential to the operation of the REQM framework is the value judgement input from the public. Each candidate measure and its impact must be examined in light of public responsiveness and acceptance before it can become part of the final maintenance strategy.

APPLICATION OF REQM FRAMEWORK

The system was applied to the development of the Baltimore air quality maintenance plan essentially as outlined above. The operative tool was a matrix, Figure 22, which provided a means of listing and displaying all the information as it was developed. Most of the entries on the form are self-explanatory. The others are defined below.

(1) Effectiveness: the percent reduction in total emissions from that source category expected from the control measure, without regard to other measures. In many cases, the estimate was made entirely subjectively, particularly in the case of land use measures.

(2) Emission Reduction: Obtained as the product of effectiveness times the source category contribution to emission.

(3) Improved Air Quality: Obtained as the product of effectiveness times the source category contribution to concentration.

(4) Administrative Considerations: Flexibility refers to the ease with with which a control measure may be applied or removed. Continuous-Non-Continuous describes whether the control must be applied all the time or whether it can be applied at some times and not others. Selective-Uniform describes the ability of the control measure to be applied to certain sources (either within a class or between classes) as opposed to all sources.

(5) Timing Considerations: The effectiveness referred to in Years Before Effectiveness Realized is that percentage identified in the column, Percentage Range of Effectiveness and the resulting emissions reduction or improved air quality listed in the following columns.

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS						% EMISSION REDUCTION	$\mu g\ m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1 NOT EXPENSIVE 2 MODERATELY EXPENSIVE 3 VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	

Figure 22. Sample matrix

(6) Economic Implication: The purpose of this section is to provide some measure of the relative economic impact of a particular control measure coupled with some policy instrument. The nature of the impact has been categorized as: (1) Direct Costs to the polluter (e.g., an industrial polluter who has to control stack emissions, or an automobile owner who has to maintain some retrofit device on his car, etc.), to the consumer (e.g., one who pays higher prices for goods or services that are more expensive because of pollution abatement regulations), to the government (as part of its transportation plan), or to some other entity that may suffer out-of-pocket costs; (2) Administrative Costs. These are indirect costs of program management, enforcement, monitoring, etc. paid by public funds for the institution and maintenance of specific pollution abatement strategies; and (3) Social Costs or costs suffered by a community or society as a whole, costs that indirectly manifest themselves as having a negative impact on area income (e.g., where opportunities for growth are forestalled), area employment (e.g., where a firm actually has to cut back its production), regional prices, or on some other measure of community or area well-being such as population level, growth rate, etc.

Several notations were utilized in the matrix rating environmental, social, economic, temporal and political criteria. The shading and numerical notations are self-explanatory. One exception may be the column entitled Public Responsiveness. The numerical entries in the five subcolumns ranging from least acceptable to most acceptable represent the number of responses for or in opposition to a particular control measure. These responses were recorded at meetings of the Air Quality Task Force. The variations in total responses between measures result from the fact that not all members responded to each measure. The composition of the Task Force was such that all groups in the BMAQMA were not equally represented and the numbers in the public responsiveness spaces should be viewed accordingly. More important, perhaps, than these numbers were the comments recorded at the meetings reflecting the concerns, questions and reactions of the group toward the measures. A Y (yes) or N (no notation was used in the legal considerations column. Finally, intermedia environmental effects were divided into five sub-categories. Positive intermedia environmental effects resulting from a particular control measure were noted with the symbol X and negative effects were noted with a minus symbol (-). Where there were no effects the space remained blank.

A separate display was made for each source category and pollutant upon which was entered that category's percent contribution to the 1985 pollutant concentration. A comprehensive list of candidate control measures and the policy instruments for implementation was made based upon the seven classes of control measures in the REQM framework. First estimates of matrix entries were entered at this time except for public responsiveness, entries for which were solicited from the Air Quality Task Force.

During the next six weeks, the matrices' entries were refined and changed and finally completed as presented in Chapter VIII. Measures were added and in some cases, because of triviality or time frame for implementation, eliminated.

A series of four meetings was held with the Air Quality Task Force during the course of development of the final plan. At each meeting the latest version of the control measure matrices was distributed to the panel for discussion and comment. In the final version, it is believed that a new consensus had been reached for each entry.

At the final meeting, a number of candidate strategies were presented to the panel for discussion and comment. These strategies are discussed in Chapter IX.

CHAPTER VIII

SELECTION OF MAINTENANCE MEASURES

INTRODUCTION

The following chapter presents the maintenance measures developed using the REQM framework. Eleven tables are presented enveloping particulate and hydrocarbon emissions. The matrices, as explained in Chapter VII, describe the generated residuals, methods for their prevention, as well as secondary impact resulting from socioeconomic implications of the control measures and policy instruments.

The tables are ordered in relation to Source Categories, beginning with Suspended Particulates (Tables 31 through 36) and continuing with Hydrocarbons (Tables 37 through 41).

(1) Domestic and Commercial Heating and Cooling (Table 31)

(2) Industrial Processing and Heating (Table 32)

(3) Power Plants (Table 33)

(4) Transportation (Table 34)

(5) Fugitive Dust (Table 35)

(6) Land Use Measures, Stationary (Table 36)

(7) Non-Automotive Sources, Stationary (Table 37)

(8) Non-Automotive Sources, Mobile (Table 38)

(9) Light Duty Vehicles (Table 39)

(10) Heavy Duty Vehicles (Table 40)

(11) Land Use Measures (Table 41)

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Preceding these tables is a list of the control measures with a brief description for each item. Their order coincides with the tables for easy reference. Several of the control measures are discussed in more detail (including specific examples of implementation and references to previous studies) and can be found in Appendix F of this report. The descriptions of the potential control measures, in some cases, include references to the policy instruments which may be used to influence the selection of that control measure.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Domestic and Commercial Heating and Cooling

The following potential control measures are applicable for domestic and commercial heating and cooling:

(1) Improve domestic and commercial insulation - Improving or upgrading building code specifications for insulation of domestic and commercial structures would effect a reduction in the amount of heat that is lost by radiation and would thus result in substantial savings in energy production due to compensating for heat loss.

(2) Control room temperatures for air conditioning and heating - Reducing thermostat settings for heating could result in an 11 percent savings in energy requirements. Raising the thermostat setting for air conditioning could result in more substantial savings due to the larger energy demands required for cooling.

(3) Concentrate new development at densities that will allow for measures to reduce emissions per capita or per unit of production - Increasing multifamily housing (as opposed to detached units), operating fewer large industrial and power generation facilities (instead of many small ones), and carefully locating new sources may result in reduced emissions per capita through economies of scale providing increased feasibility for new control equipment, as well as increased operating efficiencies.

(4) Reduce window area - Reducing the amount of window area would reduce possible entrance and exit sites for heated or cooled air. Thus

less cold air could infiltrate heated areas during winter and less heated air could escape; conversely, less cooled air could exit during summer and less radiated heat could enter through glass.

(5) Increase fuel costs - Raising the cost of fuel would tend to force the consumer to conserve; however, the regressive nature of such costs to individuals with low incomes should be considered.

(6) Diurnal room temperature - A substantial savings in fuel demand could be gained by introduction of diurnal room temperature during sleeping hours.

(7) Reduce ash content of fuel - The use of fuel processing techniques to reduce ash content would lower the amount of ash emitted during ignition/combustion.

(8) Improve furnace design - Increasing the efficiency of furnace combustion by improving design would have an overall effectiveness of 5 to 15 percent. For example, the Southern California Gas Company is recommending the use of a "turbulator" which is a baffle-type device of crooked "zig-zag" configuration that is inserted into boiler tubes. The turbulator acts to slow hot gases entering the tube thereby allowing better heat transference. The use of a turbulator has been reported to increase boiler efficiency by 15 percent.*

(9) Improve maintenance of heating/cooling systems - Amending building codes to require more frequent inspections of heating/cooling systems would enforce a higher degree of efficiency that could realize a 5 to 10 percent effectiveness (e.g., replacing worn parts, dirty air filters, etc.).

(10) Modify pilot light - Changing from a continuous pilot light in gas appliances (which annually uses 8 percent of total gas consumed) to an electrical ignitor could save 20 to 30 percent of the energy consumption of a gas range (when used in conjunction with better oven insulation).

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* Southern California Business. XXXVII (31):10. August 1974.

(11) Design home heating and air conditioning systems as a unit - A greater percentage of efficiency is obtained by installation of a bi-modal climate control system for residential units.

(12) Orientation of buildings and windows - Modifying the design of building and window orientation can reduce heating air conditioning demand from 2 to 5 percent.

(13) Install control devices on small combustion units - Changing the design specifications to modify combustion units or adding "black boxes" such as a main baghouse or high-efficiency cyclone could have an efficiency in reducing emissions of 50 to 100 percent, depending upon the degree of enforcement.

Industrial Process and Heating

The following potential control measures are applicable to industrial process and heating:

(1) Reduce demand for industrial products - Industrial process emissions are by far the most significant source of emissions in the Baltimore AQMA. Nearly 55 percent of the total particulate emissions in the Baltimore AQMA are from industrial process; therefore, a reduction in demand for products would reduce emissions.

(2) Exclude high pollutant sources from AQMA - This measure is self-explanatory.

(3) Modify production hours - Decreasing production hours would limit the amount of particulate emissions; furthermore, a shift in production hours would redistribute the amount of emissions.

(4) Modify raw material inputs - Improving the specifications of raw materials would have an effectiveness of 2 to 5 percent; selection of raw materials of high grade and consistency would produce less residual emissions during their use.

(5) Recycle residuals back into production process - The recycling of by-products from industrial processing can have an effective range of 2 percent.

(6) Improve product efficiencies - The value of improving the efficiency of energy consumptive products and the consequent reduction in energy demand is evident.

(7) Modify production output - Modifying production output would include making products more durable, improving packaging techniques to decrease the amount of material used, etc. Such methods would reduce the amount of raw materials and energy required to produce and deliver goods.

(8) Improve collection efficiency - Improving collection efficiency to improve upon EPA Standards, which currently utilize the best available technology to effect emission reduction, would require a technological breakthrough.

(9) Predict alerts - The predicting of alerts would in effect allow emergency measures to be initiated to prevent pollution from reaching dangerous levels.

Power Plants

The potential control measures for power plants are:

(1) Utilize daylight savings time - Legislation passed by Congress during the height of the energy crises, which made daylight savings time mandatory throughout the year until 1975, has an effectiveness of approximately 1 to 2 percent.

(2) Increase electrical rates for large users - Restructuring the rate scale for large users could have an effectiveness of from 2 to 5 percent.

(3) Improve domestic and commercial building insulation - See Particulates, Domestic and Commercial Heating and Cooling.

(4) Improve efficiency of electrical appliances - The value of energy efficient appliances is self-explanatory.

(5) Control room temperature for heating and air conditioning - Reduced thermostat settings for heating and raised thermostat settings for air conditioning could result in substantial savings in energy demands.

(6) Ration electricity - One option open to curtailing electrical demand may be rationing on a limited basis.

(7) Move all power plants outside the region - Move existing facilities or through attrition build new plants outside AQMA.

(8) Surround power plants with land use buffers - Providing buffer zones to surround power plants would prevent sensitive receptors (such as hospitals, schools, etc.) from locating near a potential pollutional source.

(9) Utilize storage of peak shaving with clean fuel - Having the potential to use clean fuel such as hydro power during peaks.

(10) Limit uses by area or time to even out demand - See above item (6), Ration Electricity.

(11) Reduce ash content of fuel - Reducing the ash content of fuel would decrease the amount of particulate residue that could be emitted.

(12) Convert to clean fuel - Shortages of clean burning natural gas or oil have made this measure unlikely especially when conversion of generating facilities to coal has begun on a limited basis.

(13) Generate more power in newer, larger facilities - Concentrating particulate emissions would result from operating fewer but larger generating facilities.

(14) Reduce transmission losses - Higher grade insulation coupled with higher voltage transmission results in less loss in transmission to source.

(15) Use total energy systems - Utilization of individual electric power producing units for facilities such as shopping centers and utilize by-products such as waste heat for space heating.

(16) Improve collectors - Increasing collector efficiencies will require improved technology. Immediate solution is to "add on" control devices in series.

(17) Add more collectors - See item (16), above.

(18) Increase actual stack heights - Tall stacks produce decreased ground level concentrations of suspended particulates due to increased dispersion.

(19) Increase effective stack heights - See item (18), Increase actual stack height.

(20) Utilize intermittent control with weather conditions - Controls would be used when weather conditions present an alert situation and probable increase in concentrations are predicted.

Transportation

The potential control measures for the hydrocarbon source category Transportation are equally applicable to particulates; i.e., the potential control measures to reduce hydrocarbon emissions will also effect reductions in suspended particulates and are discussed more fully later in the chapter in the sections Non-automotive Sources, Mobile (pages 126 and 127), Light Duty Vehicles (pages 127 to 130), and Heavy Duty Vehicles (pages 130 and 131). Also please refer to Tables 38, 39, and 40. For ease of reference and to present a general overview of the type of control measures applicable to this source category (Transportation), the following 12 control measures were delineated in this section (and Table 34):

(1) Reduce vehicle ownership;
(2) Improve attractiveness of other modes;
(3) Reduce number of drivers;
(4) Improve road network outside of region;
(5) Restrict highway availability;
(6) Increase gas mileage;
(7) Use smaller engine to weight ratio;
(8) Limit auto accessories;
(9) Optimize speed/volume specifications;
(10) Increase auto occupancy rate;
(11) Add emission control devices; and
(12) Predict alerts.

Fugitive Dust

(1) Reduce demand for transportation, construction, agriculture, and other activities - This measure is self-explanatory.

(2) Limit agricultural activity during dry weather - Local ordinances to curtail agricultural activity during dry weather would create a method to reduce particulates during these dry periods.

(3) Limit activity on unvegetated lots - Limiting selected activities from unvegetated lots would reduce the amount of fugitive dust generated from these sites.

(4) Modify tire and brake wear design - Redesign tires and brakes to reduce the generation of particulates during the normal vehicle operating cycle. This measure requires the implementation of basic and applied research and development programs and should probably be sponsored by the Federal Government.

(5) Eliminate unpaved parking lots - Tax incentives would be the more effective program to eliminate unpaved parking lots as fugitive dust generation sites.

(6) Control unpaved streets - Limiting access as well as speed would be an effective means of controlling unpaved streets.

(7) Plant ground cover on vacant lots - This measure is an effective means to help alleviate the amount of particulates that could be generated from vacant lots.

(8) Control construction sites - Chemical stabilization, site watering, treatment of temporary access roads to main thoroughfares and minimizing the period during which cleared and regraded lands are exposed are means to limit the amount of dust from construction sites.

(9) Limit speed on unpaved roads - See item (6), above.

(10) Control of open bodied vehicles - Covering of large open bodied vehicles while carrying full loads of dirt would considerably reduce the fugitive dust emitted while in transit.

(11) Control of deposition of roads - Washing down construction vehicles before leaving project sites would have a range of effectiveness from 10 to 25 percent in the control of fugitive dust.

Land Use Measures, Stationary

The following measures are applicable to land use.

(1) Exclude new sources from selected hot spots - Areas which have been designated as high areas of pollution should be excluded from any consideration of new development that might further degrade the ambient air quality of the region.

(2) Exclude high pollutant sources from AQMA - This measure is self-explanatory.

(3) Concentrate new development at densities which allow for measures to reduce emissions per capita or per unit - Increasing multi-family housing (as opposed to detached units), operating fewer large industrial and power generation facilities (instead of many small ones), and carefully locating new sources may result in reduced emissions per capita through economies of scale providing increased feasibility for new control equipment, as well as increased operating efficiencies.

(4) Control of existing land uses - Utilize zoning or urban development to control existing land use activities and possibly replace, through attrition, older high emission sources with new low emission facilities.

(5) Regulate timing of new development - Controls can be utilized to regulate new development so that it coincides with the introduction of new control technology for existing sources or with their removal.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS

Non-Automotive Sources, Stationary

The control measures include:

(1) Reduce demand for reactive hydrocarbon solvents - Through taxes and fees, a reduction in reactive hydrocarbon solvents should be initiated to reduce emissions from these sources from 25 to 50 percent.

(2) Improve methods of bulk storage - Reduction of automotive travel in turn limits the amount of gasoline required in reserve bulk storage; in turn less handling is required and the chances of accidental spills are lessened.

(3) Regulate service station, terminal facilities - Reducing handling and leakage and increasing storage and transportation could have an effectiveness of 2 to 4 percent.

(4) Improve service station storage - The reduction of emissions from service station pumps and terminal loading would be reduced proportionately to the reduction of usage.

(5) Change industrial process - Change process methods for individual industrial operations to eliminate wasteful or heavy pollutional loading emissions.

(6) Control miscellaneous gasoline engines - The banning of gasoline power mowers through fees, or the application of emissions control regulations to all gasoline engines are measures that could be applied to reduce hydrocarbon emissions.

(7) Regulate refuse incineration - The reduction in emissions resulting from incineration of solid waste can be achieved by more complete incineration; however, this will produce only marginal improvements in what is already a minor source.

Non-Automotive Sources, Mobile

(1) Controls on diesel and shipping - The potential control measures for the section Heavy duty vehicles pages 130 and 131 are applicable to this control measure.

(2) Reduce demand for diesel and shipping - Policies which would reduce the requirements for the transportation of goods to the region or within the region would in turn reduce the demand for the operation of diesel-powered engines and thereby reduce the hydrocarbon emissions.

(3) Reduce emissions from diesel engines - Due go the small share of total emissions, diesel engines have not been subject to the same control as gasoline-powered engines. In the very near future this will change due to the emission controls placed on automobiles. It is estimated that the introduction of new emission standards on all new diesel-powered trucks, and on other diesel engines in the Baltimore region could reduce hydrocarbon emissions from those sources by up to 50 percent.

(4) Relocate truck traffic from region - Construction of a circumferential highway around the region could reduce emissions from diesel bus and truck traffic in the region.

(5) Episodic controls - Ban on non-essential truck travel has the potential to reduce the hydrocarbon emissions from diesel trucks during poor meteorological conditions.

(6) Control aircraft emissions - Limited reductions of hydrocarbon emissions from aircraft and aircraft related activities can result from: (a) reduction in flights; (b) use of larger, cleaner aircraft; (c) reduction of ground maneuvers; and (d) control of non-aircraft ground sources.

(7) Reduce low speed running of aircraft engines - Revision of aircraft taxiing maneuvers are currently being revised in major airports. Taxiing with only two engines running, aircraft towing, reduction of run-ups, and use of mobile lounges are being considered.

(8) Reduce ground equipment emissions - Ground support vehicles contribute approximately 30 percent of the total airport-generated vehicular traffic; this can be reduced by the following methods: (a) installing control devices on fuel handling equipment at the airport to prevent spills, (b) limiting movement of ground support vehicles, and (c) limiting automobile access to airport.

Light Duty Vehicles (LDV)

A prime means of reducing hydrocarbon emissions is to reduce the total daily amount of automobile travel. Measures and policy instruments are summarized below; for a more detailed description, refer to Appendix F.

(1) Reduce vehicle ownership - This may be attained in three ways: applying additional excise taxes on new vehicles, reducing the number of eligible drivers and instituting a strict vehicle inspection system.

(2) Divert auto passengers to transit and rail - This measure could be accomplished by making major improvements in the level of transit service, for example increasing the frequency of current service

and expanding new service which may employ new busways. Also, the reduction of public transportation fares (possibly to zero) is another incentive to lure auto riders to transit. As a disincentive to auto driving, increased downtown parking costs would influence the modal split in favor of less expensive transit alternatives.

(3) Reduce number of drivers - This method would establish age restrictions, for example raising the permitted age for drivers from 16 to 18 or setting an upper limit on permitted age (e.g. 62). Other restrictions on drivers could include a more liberal use of license revocation for multiple violations or selected types of violations.

(4) Decrease the use of highways - Highway tolls and extra taxes on gasoline would dissuade highway travel. Any other additional expense directly incurred in auto use would tend to discourage travel.

(5) Reduce am peak period VMT - Variations in the typical work week will change the intensity of auto travel during the am peak period. For example, the four day, 40-hour work week would mean that employees would work four 10-hour days instead of the regular five 8-hour days during the week. Staggered work hours, on the other hand, could perhaps lengthen the entire peak period but decrease the intensity of the peak as people came to work in shifts from 6 to 7, 7 to 8, and 8 to 9. Carpooling, by increasing auto occupancy, also represents a way to reduce the number of cars on the road during the am peak period journey to work. Many computerized efforts have been initiated in major cities to identify potential carpool participants.

(6) Reduce summer VMT - Coordination of vacations could shift a higher percentage of vacations to the period June through August and thereby reduce the number of employee auto trips to work. As another measure, fuel rationing for the summertime could be instituted, and, during the three-month period, the rationing would decrease the propensity to make auto work trips. Federal and state control and monitoring of such a rationing scheme would be required.

(7) Restrict travel - A variety of approaches to fuel rationing would address this control measure. For example, a year-round rationing program might ration fuel to the retailer or wholesaler as was experienced in the 1973-1974 winter allocation program. These approaches would require Federal and state participation and should be national policy as opposed to region-wide to be successful.

(8) Relocate traffic out of the region - Through traffic could be diverted from travelling in the region by affording clearly identified circumferential routes. These routes would conceivably be as fast or faster to auto drivers as the peak hour trip through Baltimore congestion and would eliminate the frustrations tied to driving in busy rush hour conditions.

(9) Restrict highway construction/improvements - This control measure can be attained by withholding grants and funds for further new construction or major improvements. In so doing, tax dollars would be saved for other purposes--perhaps encouraging faster progress on the rapid rail system. The selection of which highways are and are not to be constructed or improved would determine the extent of effectiveness of this measure.

(10) Decrease use of auto accessories - Heavy excise taxes on non-essential auto accessories would inhibit their purchase and use and subsequently increase the mileage of auto engines. These non-essential auto accessories include air conditioning, power brakes, power steering and other secondary users of gasoline.

(11) Modify engine type - The policy instruments related to this control measure include the use of electric-engined automobiles. It must be recognized that this measure could only be realized when electric engines became a product reality.

(12) Encourage optimum traffic flow - Improved traffic flow can be promoted chiefly through TOPICS programs, and improvements in signalization, intersection design, parking restrictions and other roadway improvements. Capacity restrictions can be implemented through freeway surveillance, driver information systems and ramp metering to increase the efficiency of highway traffic.

(13) Increase auto occupancy - Auto occupancy can be increased through parking incentives, i.e., reduced rates for carpool cars or reserved spaces for carpool cars. Other forms of incentives include tax reductions and insurance premium reductions for carpool participants. Express lanes available for carpool use encourage higher auto occupancy.

(14) Improve emission controls - Stricter standards at the Federal level would improve the total auto emissions produced. For instance, if standards were established to control emissions per gallon instead of emissions per mile regardless of engine size, then total auto hydrocarbon emissions would be further reduced.

(15) Alert control of VMT - This control measure can be employed by imposing periodic bans on auto travel. Restrictions on non-essential trips would be one way of effecting total auto travel during periods of high emission levels. Auto stickers issued on the basis of family size and other factors would assist in enforcing partial bans on driving. Emergency holidays for employees based upon periods of high emission conditions would also control auto driving as required in the summer.

Heavy Duty Vehicles (HDV)

In reducing the total VMT contributed by heavy duty vehicles, the following measures and policy instruments are appropriate:

(1) Reduce truck ownership - As with the policy instruments applied to automobile ownership, increased fees and taxes as well as more rigorous inspection are deterrents to excessive truck ownership.

(2) Reduce gasoline truck ownership - This policy instrument is more precise that the one above and would call for fees and taxes which discriminate against gasoline truck ownership and in favor of diesel and electric-engined vehicles when the latter are produced and marketed widely.

(3) Prohibit truck movement - Within truck-free zones, trucks would be prohibited either completely or within certain hours of the day. Multiple use and coordination of truck deliveries for government offices including the diversion of truck deliveries to public transit vehicles during off peak hours afford a further possibility for limiting truck

movements. In better defining truck routes, local and regional agencies can assist in the smoother flow of truck traffic. Route selection and delivery schedules are primarily the responsibility of private businesses.

(4) Reduce am peak period VMT - Prohibiting truck movement in the am peak period or eliminating the use of thoroughfares to trucks in the morning rush hours would decrease hydrocarbon emissions from trucks in proportion to the number off the road and would further reduce hydrocarbon emissions from light duty vehicles which can flow more easily in the absence of trucks. Restricted loading zones would further discourage truck travel in the critical am peak period.

(5) Modify engine type - Policy instruments related to this control include replacement of the gasoline engine in heavy duty vehicles by the electric engine. Manufacturer's specifications would be required and complementary incentives for smaller engined trucks include possible tax incentives.

(6) Increase use of smaller vehicles - Taxation by weight would encourage smaller engined truck ownership, thus encouraging the use of light duty trucks which are currently under stricter controls.

(7) Improve emission controls - This measure would rely on a policy instrument of mandatory retrofitting of emission control devices on trucks. This is a requirement which necessitates new Federal standards and implementation at the Federal and state levels.

(8) Episodic control of VMT - A ban on non-essential truck travel during high pollution periods would be similar to the measure proposed for light duty vehicles. A sticker system would allow travel on alternate days or some other proportional approach. Emergency holidays for public and private employees, including truck drivers, would provide episodic control.

Land Use Measures

Refer to Appendices F and G.

Table 31. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

DOMESTIC AND COMMERCIAL HEATING AND COOLING

SOURCE CATEGORY DOMESTIC AND COMMERCIAL HEATING AND COOLING 18% TSP CONCENTRATION 13% PARTICULATE EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
		0-2	2-5	5-10	10-25	25-50	50-100	%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
IMPROVE DOMESTIC AND COMMERCIAL INSULATION	BUILDING CODES			●				1.0	1.1	1	2	1	-	1	1	1	-	1	1	1	-	●				●		●		●					●					●		Y	Y	X			X	X	1	2	0	3	5	
CONTROL ROOM TEMP FOR A C AND HEATING	ADVERTISING			●				1.0	1.1	1	2	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●				●	●	●	●	●	Y	N	X				X	0	3	4	2	2	
CONCENTRATE NEW DEVELOPMENT AT DENSITIES WHICH ALLOW	INCREASING MULTI-FAMILY HOUSING AS OPPOSED TO DETACHED UNITS	●						1	1	2	2	1	-	1	1	1	-	1	1	1	-		●			●				●				●			●	●		●		Y	Y	X				X	9	0	1	0	0	
FOR MEASURE TO REDUCE EMISSIONS PER CAPITA OR PER UNIT OF PRODUCTION																																																						
REDUCE WINDOW AREA	BUILDING CODES		●					5	.5	1	1	1	-	1	1	1	-	1	1	1	-	●				●		●		●					●		●	●		●	●	Y	Y	X				X	4	1	2	0	1	
INCREASE FUEL COSTS	TAXES; SURCHARGE	●						1	.1	1	1	2	-	1	1	1	-	1	1	1	-		●			●		●		●					●					●		Y	Y	X		X		X	1	2	4	1	0	
DIURNAL ROOM TEMP	SPECIFICATION		●					5	.5	1	1	1	-	1	1	1	-	1	1	1	-				●	●		●		●			●								●	N	N	X				X	1	1	2	0	5	
REDUCE ASH CONTENT OF FUEL	TAX POLICY			●				1.0	1.1	2	2	1	-	1	1	1	-	1	1	1	-	●				●		●			●				●		●	●		●	●	Y	Y	X					1	5	1	1	2	
IMPROVE FURNACE DESIGN	IMPROVE DESIGN SPECS			●				1.0	1.1	2	2	1	-	1	1	1	-	1	1	1	-	●				●		●			●				●		●				●	N	Y	X				X	0	0	1	2	6	
IMPROVE MAINTENANCE OF HEATING COOLING SYSTEMS	REGULATORY CODE			●				1.0	1.1	1	2	1	-	1	1	1	-	1	1	1	-			●			●	●		●			●							●	●	Y	Y	X				X	0	1	1	1	6	
MODIFY PILOT LIGHT	MODIFY DESIGN	●						1	1	1	1	1	-	1	1	1	-	1	1	1	-									●			●				●				●	N	Y					X	0	0	0	1	7	
DESIGN HOME HEATING AND A C SYSTEM AS UNIT	DESIGN SPECS CODE REQUIREMENT SUBSIDIES	●						1	1	1	1	1	-	1	1	1	-	1	1	1	-	●				●		●		●						●	●	●		●		Y	Y	X				X	1	1	2	3	3	
ORIENTATION OF BUILDINGS AND WINDOWS	DESIGN SPECS CODE REQUIREMENTS SUBSIDIES		●					5	5	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●						●	●	●		●		Y	Y					X	1	1	1	3	5	
INSTALL CONTROL DEVICES ON SMALL COMBUSTION UNITS	REGULATIONS IMPROVE DESIGN SPECS						●	9.8	10.8	1	1	1	-	1	1	1	-	1	1	1	-	●				●				●					●		●	●		●		Y	Y						7	0	1	1	2	

Table 32. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

INDUSTRIAL PROCESSING AND HEATING

SOURCE CATEGORY INDUSTRIAL PROCESSING AND HEATING 9%TSP CONCENTRATION 52% OF PARTICULATE EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
REDUCE DEMAND FOR INDUSTRIAL PRODUCTS	PRICE CONTROLS, TAXES, FEES		●					1.8	0.3	2	1	1	-	1	1	1	-	2	3	3	-		●			●		●		●				●			●	●		●		N	Y			X		X	8	1	0	0	0	
EXCLUDE HIGH POLLUTANT SOURCES FROM AQMA	LAND USE CONTROLS	●	●	●	●	●	●	26.1	0.1	1	1	1	-	1	1	1	-	1	1	1	-		●							●						●				●		Y	Y		X		X		0	1	3	1	4	1
MODIFY PRODUCTION HOURS	LOCAL ORDINANCES	●						.5	0.1	1	1	1	-	1	1	1	-	2	2	1	-			●		●		●		●			●							●		Y	Y		X		X		1	3	1	0	3	
MODIFY RAW MATERIAL INPUTS	SPECIFICATIONS		●					1.8	0.3	2	1	1	-	1	1	1	-	1	1	2	-		●			●		●			●				●			●			●	Y	Y		X	X	X		0	0	3	2	3	
RECYCLE RESIDUALS BACK INTO PRODUCTION PROCESS	ECONOMIC INCENTIVES	●						.5	0.1	2	1	1	-	1	1	1	-	1	1	1	-			●			●	●			●				●			●				Y	Y		X	X	X	X	0	1	2	1	4	
IMPROVE PROD. EFFICIENCIES	IMPROVE DESIGN SPECS.	●						.5	0.1	1	1	1	-	1	1	1	-	1	1	2	-				●	●		●			●				●						●	Y	Y		X		X		0	0	0	1	8	
MODIFY PROD. OUTPUT	PROD. DESIGN SPECIFICATIONS		●					1.8	0.3	2	1	1	-	1	1	1	-	1	1	2	-				●	●		●				●				●	●	●			●	N	Y		X	X		X	0	0	1	3	4	
IMPROVE COLLECTION EFFICIENCY	REGULATORY CODE	●						.5	0.1	1	1	1	-	1	1	1	1	1	1	1	-		●			●		●		●				●			●	●	●			Y	N				X	X	0	0	3	0	5	
PREDICT ALERTS	IMPROVE FORECASTING	●						.5	0.1	1	1	2	-	1	1	1	-	1	1	1	-				●		●		●	●			●						●			Y	N						0	0	1	1	3	

Table 33. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

POWER PLANTS

SOURCE CATEGORY POWER PLANTS 1% OF TSP CONCENTRATION 5.1% OF PARTICULATE EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g\ m^{3}$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
		0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
UTILIZE DAYLIGHT SAVINGS TIME	CONGRESSIONAL ACT	●						05	0	1	1	1	-	1	1	1	-	1	1	1	-				●				●	●				●			●	●				Y	Y					X	3	1	2	1	1	
INCREASE ELECTRIC RATES FOR LARGE USERS	REQUIRE RATE STRUCTURE		●					2	0	1	2	2	-	1	1	1	-	1	1	1	-			●				●		●			●					●	●			Y	N					X	0	2	2	1	4	
IMPROVE DOMESTIC AND COMMERCIAL BLDG. INSULATION	BUILDING CODES; SUBDIVIDER	●						1	0	1	2	1	-	1	1	1	-	1	1	1	-		●					●		●					●			●		●		Y	Y					X	1	2	0	3	3	
IMPROVE EFFICIENCY OF ELECTRIC APPLIANCES	DESIGN SPECIFICATIONS		●					.2	0	1	2	1	-	1	1	1	-	1	1	1	-	●						●		●					●		●				●	N	Y					X	0	0	1	4	6	
CONTROL ROOM TEMP. FOR HEATING AND A.C.	ADVERTISING		●					2	0	1	1	1	-	1	1	1	-	1	1	1	-								●	●				●					●	●	●	Y	N					X	0	2	4	2	2	
RATION ELECTRICITY	INCREASE RATES; ALLOCATION SCHEME	●						1	0	1	1	1	-	1	1	1	-	1	1	1	-			●			●	●		●				●			●	●		●		Y	Y					X	7	1	1	0	0	
MOVE ALL POWER PLANTS OUTSIDE OF REGION	SITING POLICY					●		1.9	0.3	3	2	1	-	1	1	1	-	2	2	2	-										●				●			●			●	Y	N						3	1	3	0	3	
SURROUND POWER PLANTS WITH LAND USE BUFFERS	ZONING EASEMENTS	●						.1	0	1	1	1	-	1	1	1	-	1	1	1	-									●					●					●		Y	N						1	1	3	1	0	
UTILIZE STORAGE OR PEAK SHAVING WITH CLEAN FUEL	DESIGN NEW CLEAN GENERATING SOURCES	●						1	0	1	1	1	-	1	1	1	-	1	1	1	-									●			●					●			●	Y	N						1	0	4	0	2	1
LIMIT USERS BY AREA OR TIME TO EVEN OUT DEMAND	RATION ELECTRICITY	●						.1	0	1	1	1	-	1	1	1	-	1	1	1	-									●			●					●		●	●	Y	N						2	3	3	1	0	
REDUCE ASH CONTENT OF FUEL	TAX POLICY				●			.9	0.1	2	2	1	-	1	1	1	-	1	1	1	-										●				●		●	●		●	●	Y	Y			X			1	1	2	4	2	
CONVERT TO CLEAN FUEL	TAX POLICY						●	3.8	0.6	2	2	1	-	1	1	1	-	1	1	1	-										●				●		●	●		●	●	Y	Y	X	X	X			1	2	0	2	4	
GENERATE MORE POWER IN NEWER LARGER FACILITIES	SUBSIDIES GRANTS	●						1	0	1	1	1	-	1	1	1	-	1	1	1	-											●				●		●			●	Y	Y	X		X	X	X	0	2	2	1	2	
REDUCE TRANSMISSION LOSSES	DESIGN SPECS. FOR HIGHER VOLTAGES AND INSULATION	●						.1	0	2	1	1	-	1	1	1	-	1	1	1	-											●				●		●			●	Y	N				X	X	0	1	3	0	4	
USE TOTAL ENERGY SYSTEMS	GRANTS, SUBSIDIES ECON. INCENTIVES		●					.2	0	1	1	1	-	1	1	1	-	1	1	1	-											●				●	●	●	●	●	●	Y	Y	X		X	X	X	1	0	4	3	1	

Table 33. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES (Cont.)

POWER PLANTS

SOURCE CATEGORY POWER PLANTS (CONTINUED)		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	ug m^3 IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
		0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
IMPROVE COLLECTORS	MAINTENANCE PROGRAM INSPECTION	●						.1	0	2	2	1	-	1	1	1	-	1	1	1	-										●				●		●	●		●	●			x	-	x			0	3	2	2	2	
ADD MORE COLLECTORS	SUBSIDIES TAX INCENTIVE	●						.1	0	2	2	1	-	1	1	1	-	1	1	1	-										●				●		●	●		●	●			x	-	x			0	2	2	2	2	
INCREASE ACTUAL STACK HEIGHTS	IMPROVE DESIGN	●						.1	0	2	2	1	-	1	1	1	-	1	1	1	-									●				●			●	●			●								2	2	0	0	1	2
INCREASE EFFECTIVE STACK HEIGHTS	IMPROVE DESIGN		●					.2	0	2	1	1	-	1	1	1	-	1	1	1	-									●			●				●	●			●								0	3	1	0	1	
UTILIZE INTERMITTENT CONTROL WITH WEATHER CONDITIONS	REGULATE	●						.1	0	1	1	1	-	1	1	1	-	1	1	1	-									●			●				●	●	●	●				x	x	x	x	x	0	0	1	3	2	3

Table 34. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

TRANSPORTATION

SOURCE CATEGORY TRANSPORTATION 16% TSP CONCENTRATION 20% PARTICULATE EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	ug/m^3 IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
		0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
REDUCE VEHICLE OWNERSHIP	TAXES, SURCHARGES		●					0.7	0.4	1	1	1	-	1	1	1	-	2	2	2	-		●			●		●		●			●					●				N	Y	X										
IMPROVE ATTRACTIVENESS OF OTHER MODES	GRANTS, SUBSIDIES			●				1.7	1.1	1	1	2	-	2	1	1	-	1	1	1	-			●		●		●			●				●		●	●		●		Y	Y	X										
REDUCE NUMBER OF DRIVERS	ANNUAL TESTING, INCREASE COST	●						0.2	0.1	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●				●	●		●		N	Y	X										
IMPROVE ROAD NETWORK OUTSIDE REGION	GRANTS, SUBSIDIES	●						0.2	0.1	1	1	2	-	1	1	1	-	1	1	1	-		●			●		●			●			●								Y	N	X										
RESTRICT HIGHWAY AVAILABILITY	WITHHOLD GRANTS, FUNDS				●			3.5	2.2	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●				●				●		●		N	Y	X										
INCREASE GAS MILEAGE	TAXES	●						0.2	0.1	1	1	1	-	1	1	1	-	1	1	1	-			●		●			●	●				●			●	●				Y	N	X										
USE SMALLER ENGINE TO WEIGHT RATIO	TAX BY WEIGHT OR DISPLACEMENT		●					0.7	0.4	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●				●				●				Y	N	X										
LIMIT AUTO ACCESSORIES	TAXES, DESIGN CHANGES	●						0.2	0.1	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●				●			●	●				N	Y	X										
OPTIMIZE SPEED/VOL. SPECS.	HIGHWAY IMPROVEMENT	●						0.2	0.1	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●				●			●	●		●		N	Y	X										
INCREASE AUTO OCCUPANCY RATE	PARKING INCENTIVES	●						0.2	0.1	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●				●				●	●	●		Y	Y	X										
ADD EMISSION CONTROL DEVICES	FEDERAL SPECIFICATIONS				●			3.5	2.2	1	2	1	-	2	2	2	-	1	1	1	-		●			●			●		●				●		●	●	●	●		Y	Y	X										
PREDICT ALERTS	BAN ON NON-ESSENTIAL TRAFFIC	●						0.2	0.1	1	1	1	-	1	1	1	-	1	1	1	-				●				●	●				●			●	●	●	●		Y	N	X										

Table 35. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

FUGITIVE DUST

SOURCE CATEGORY FUGITIVE DUST 2.5% OF TSP CONCENTRATION - % OF PARTICULATE EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1 NOT EXPENSIVE 2 MODERATELY EXPENSIVE 3 VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	%EMISSION REDUCTION	μg/m³ IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
REDUCE DEMAND FOR TRANSP. CONST. AGRIC. & OTHER ACTIVITIES	TAX POLICY			●					1.5	1	1	1	-	1	1	1	-	1	1	1	-		●				●				●				●		●	●		●		N	Y	X	X		X	X	2	1	3	2	1	
LIMIT AGRI. ACTIVITIES DURING DRY WEATHER	LOCAL ORDINANCES		●						0.7	2	2	1	-	1	1	2	-	2	1	2	-		●				●	●		●				●				●		●		N	Y		X				5	1	2	1	0	
LIMIT ACTIVITY ON UN-VEGETATED LOTS	LOCAL ORDINANCES		●						0.7	1	1	1	-	1	1	1	-	1	1	1	-			●			●	●		●			●					●		●		N	Y		X				1	1	2	3	3	
MODIFY TIRE AND BRAKE WEAR DESIGN	DESIGN SPEC. FOR GREATER DURABILITY		●						0.7	1	2	1	-	1	1	1	-	1	1	1	-		●			●		●		●				●			●				●	N	Y		X				0	0	2	2	3	1
ELIMINATE UNPAVED PARKING LOTS	LOCAL ORDINANCES TAX INCENTIVES		●						0.1	3	2	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●		●		Y	Y		X				1	0	2	4	3	
CONTROL UNPAVED STREETS	LIMIT ACCESS	●							0.2	1	1	2	-	1	1	1	-	1	1	1	-				●		●	●		●			●					●		●		Y	N		X				0	0	1	4	5	
PLANT GROUND COVER ON VACANT LOTS	LOCAL ORDINANCES, GRANTS, SUBSIDIES			●					1.5	1	1	1	-	1	1	1	-	1	1	1	-				●	●		●		●			●							●	●	Y	Y		X				0	1	3	3	5	2
CONTROL CONSTRUCTION SITES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●					●		●		Y	N		X				0	0	1	3	4	
LIMIT SPEED ON UN-PAVED ROADS	LIMIT ALLOWABLE RURAL SPEEDS	●							0.2	1	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●					●		●		Y	N					X	0	1	1	3	3	
CONTROL OF OPEN BODIED VEHICLES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	2			1	1	1	-	●				●			●	●			●							●		Y	Y		X				-	-	-	-	-	
CONTROL OF DEPOSITION ON ROADS	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	1	1		1	1	1	-		●			●		●		●			●							●		Y	Y		X				-	-	-	-	-	

Table 36. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

LAND USE MEASURES, STATIONARY

SOURCE CATEGORY LAND USE MEASURES, STATIONARY		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
EXCLUDE NEW SOURCES FROM SELECTED HOT SPOTS	REVISION OF GENERAL & ZONING PLAN	●							2.2	2	1	2	-	2	1	1	-	2	2	2	-			●							●				●					●		Y	N	X	X	X	X	X						1
EXCLUDE HIGH POLLUTANT SOURCES FROM AQMA	SPECIAL USE PERMITS	●							0.9	2	1	1	-	1	1	1	-	1	1	1	-		●						●		●				●					●		Y	N	X	X	X								
	FLOATING ZONE	●							0.9	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●			●							●		Y	N	X	X	X	X							2
	PERFORMANCE STANDARDS	●							0.9	2	1	1	-	1	1	1	-	1	1	1	-		●			●			●	●			●							●		Y	Y	X	X		X	X						
	EIS/EIR - A-95	●							0.9	2	1	2	-	2	1	1	-	2	2	1	-			●				●		●				●				●	●	●		Y	Y	X	X	X	X	X						
	EMISSION DENSITY ZONING	●							0.9	2	1	1	-	1	1	1	-	2	2	2	-		●			●			●	●			●							●		Y	Y	X	X	X	X	X						
CONCENTRATE NEW DEVELOPMENT AT DENSITIES WHICH ALLOW FOR MEASURES TO REDUCE EMISSION PER CAPITA OR PER UNIT	SPECIAL PERMITS	●							0.1	2	1	1	-	1	1	1	-	1	1	1	-		●						●		●				●					●		Y	N	X	X		X							3
	FLOATING ZONES	●							0.1	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●										●		Y	N	X	X	X	X							
	AGRI CONSER. ZONES	●							0.1	1	2	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●							●		Y	N	X	X	X	X							
	HOLDING ZONES	●							0.1	1	1	2	-	1	1	1	-	2	2	1	-		●				●	●		●			●							●		Y	Y	X		X								
	LAND BANKING	●							0.1	1	1	3	-	1	1	1	-	1	1	1	-			●			●	●		●				●				●		●		Y	Y	X		X								
	PUD	●							0.1	1	1	1	-	1	1	1	-	1	1	2	-			●		●		●		●				●						●		Y	N	X	X		X	X						
	TAX POLICY	●							0.1	2	2	1	-	2	1	2	-	2	1	2	-		●				●		●	●					●			●		●		Y		X	X		X	X						
CONTROL OF EXISTING LAND USES	REVISION OF GENERAL & ZONING PLAN								5.4	2	1	2	-	2	1	1	-	2	2	2	-			●							●				●					●		Y	N	X	X	X	X	X						4
	URBAN RENEWAL & REDEVEL. INCENTIVES								5.4	1	2	3	-	3	2	1	-	1	1	1	-			●				●			●			●			●			●		Y	N	X	X	X	X	X						

Table 36. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES (Cont.)

LAND USE MEASURES, STATIONARY

SOURCE CATEGORY LAND USE MEASURES, STATIONARY (CONTINUED)		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS INTERMEDIA					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION																	
		0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
CONTROL OF EXISTING LAND USES (CONTINUED)	TAX POLICY (1) LOCATION INCENTIVES (2) RAPID AMORTIZATION		●						5.4	2	2	1	-	2	1	2	-	2	1	2	-		●				●		●	●					●			●		●		Y		X	X		X	X						
	LAND BUFFERS THROUGH PURCHASE PUBLIC PRIVATE OR ZONING		●						5.4	1	1	2	-	1	1	1	-	1	1	1	-	●				●		●		●			●					●		●	●	Y	Y	X			X	-						
REGULATE TIMING OF NEW DEVELOPMENT	REVISION OF GENERAL & ZONING PLAN	●							0	2	1	2	-	2	1	1	-	2	2	2	-			●							●									●		Y	N	X	X	X	X	X						5
	DEVELOPMENT DISTRICTS	●							0	1	1	1	-	1	1	2	-	1	1	1	-			●		●		●			●				●			●		●				X			X	-						
	MORATORIA	●							0	2	2	2	-	1	1	1	-	2	1	2	-	●				●		●		●			●					●		●		Y	Y	X	X	X	X	X						
	EIS EIR	●							0	2	1	2	-	2	1	1	-	2	2	1	-			●				●		●				●				●	●	●		Y	Y	X	X	X	X	X						
	HOLDING ZONES LAND BANKING	●							0	1	1	3	-	1	1	1	-	2	2	1	-		●				●	●		●			●							●		Y	Y	X			X							
	TAX POLICY	●							0	2	2	1	-	2	2	2	-	2	1	2	-		●				●		●	●					●			●		●		Y		X	X		X	X						
	CAPITAL IMPROVEMENTS PROGRAMMING	●							0	1	1	1	-	1	1	1	-	1	1	1	-		●			●			●	●			●							●		Y	Y	X				X						

Table 37. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS
NON-AUTOMOTIVE SOURCES, STATIONARY

SOURCE CATEGORY NON-AUTOMOTIVE SOURCES, STATIONARY 28% OF HYDROCARBON EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
REDUCE DEMAND FOR REACTIVE HC SOLVENTS	TAXES & FEES				●			4.9		3	2	1	-	1	1	1	-	1	1	1	-		●				●	●		●				●			●	●		●		Y	Y	X										
	BAN REACTIVE SOLVENTS					●		10.5		3	2	1	-	1	2	1	-	1	1	1	-	●				●		●		●				●			●	●		●		N	Y	X	X									
IMPROVE METHODS OF BULK STORAGE	FLOATING ROOF OR VAPOR RECOVERY SYSTEM		●					2.0		3	1	1	-	1	1	1	-	1	1	1	-		●			●				●					●		●	●		●		N	Y	X										
REGULATE SERVICE STATION, TERMINAL FACILITIES	REDUCE HANDLING OPERATIONS	●						0.3		2	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●	●	●		N	Y	X										
	LARGER GASOLINE TANK, TRUCK TANKS, & STORAGE TANKS							0.3		2	1	1	-	1	1	1	-	1	1	1	-																					N	Y	X										
IMPROVE SERVICE STATION STORAGE	REDUCE LEAKAGE	●						0.3		1	1	1	-	1	1	1	-	1	1	1	-		●			●			●	●			●					●		●	●	Y	Y	X										
	INSTALL VAPOR RECOVERY & FLOATING ROOFS	●						0.3		2	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●		●	●	N	Y	X										
CHANGE INDUSTRIAL PROCESS	MODIFY PRODUCTION HOURS, LIMIT OUTPUT		●					2.0		3	2	1	-	1	1	1	-	2	2	2	-		●				●	●		●			●					●		●		Y	Y	X	X	X	X	X						
CONTROL MISCELLANEOUS GASOLINE ENGINES	BAN	●						2.0		3	1	1	-	1	2	2	-	1	1	1	-	●				●		●		●			●				●	●	●	●	●	Y	Y	X			X	X						
	CHARGE USE FEE	●						0.3		2	2	2	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●		●		Y	Y	X			X	X						
	EMISSION CONTROL REGISTERS	●						0.3		1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●			●					●		●		Y	Y	X										
REGULATE REFUSE INCINERATION	BAN	●						0.3		2	1	2	-	2	3	2	-	1	1	1	-	●				●				●			●				●	●	●	●	●	Y	Y	X			X	X						

Table 38. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS
NON-AUTOMOTIVE SOURCES, MOBILE

SOURCE CATEGORY: NON-AUTOMOTIVE SOURCES, MOBILE
13% OF HYDROCARBON EMISSIONS

ECONOMIC IMPLICATIONS
1. NOT EXPENSIVE
2. MODERATELY EXPENSIVE
3. VERY EXPENSIVE

CONTROL MEASURES	POLICY INSTRUMENTS	PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	ug m^3 IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS: DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS			
		0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)
CONTROLS ON DIESEL & SHIPPING	LAND USE CONTROL		●					0.5		2	2	1	-	2	2	2	-	1	1	1	-
REDUCE DEMAND FOR DIESEL AND SHIPPING	TAX POLICY	●						0.1		1	1	1	-	1	1	1	-	1	1	1	-
REDUCE EMISSIONS FROM DIESEL ENGINES	EMISSION STANDARDS FOR DIESEL ENGINES	●						0.1		2	1	1	-	1	1	1	-	1	1	1	-
	EMISSION CONTROLS ON DIESEL ENGINES	●						0.1		2	2	1	-	1	1	1	-	1	1	1	-
RELOCATE TRUCK TRAFFIC FROM REGION	CIRCUMFERENTIAL HIGHWAYS	●						0.1		1	1	1	-	1	1	1	-	2	2	2	-
EPISODIC CONTROLS	BAN NON-ESSENTIAL TRUCK TRAFFIC	●						0.1		1	1	1	-	2	2	2	-	1	1	1	-
CONTROL AIRCRAFT EMISSIONS	REDUCE DEMAND FOR AIR TRAVEL	●						0.1		2	1	1	-	1	1	1	-	1	2	1	-
	LIMIT OPERATIONS	●						0.1		3	1	1	-	1	1	1	-	2	2	1	-
REDUCE LOW SPEED RUNNING OF AIRCRAFT ENGINES	GROUND MANEUVERS	●						0.1		1	1	1	-	1	1	1	-	1	1	1	-
	TOWING	●						0.1		1	1	1	-	1	1	1	-	1	1	1	-
	MOBILE LOUNGES	●						0.1		2	2	1	-	1	1	1	-	1	1	1	-
REDUCE GROUND EQUIPMENT EMISSIONS	VAPOR RECOVERY DEVICES ON FUEL HANDLING		●					0.1		1	1	1	-	1	1	1	-	1	1	1	-
	LIMIT GROUND SUPPORT VEHICLES	●						0.1		1	1	1	-	1	1	1	-	1	1	1	-

CONTROL MEASURES	POLICY INSTRUMENTS	ADMINISTRATIVE CONSIDERATIONS: FLEXIBILITY				APPLICATION OF CONTROL				TIMING CONSIDERATIONS: YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				POLITICAL CONSIDERATIONS: LEVEL OF IMPLEMENTATION				
		INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE
CONTROLS ON DIESEL & SHIPPING	LAND USE CONTROL			●		●		●		●					●		●	●	●	●	
REDUCE DEMAND FOR DIESEL AND SHIPPING	TAX POLICY		●			●		●		●				●				●	●		●
REDUCE EMISSIONS FROM DIESEL ENGINES	EMISSION STANDARDS FOR DIESEL ENGINES		●			●		●			●			●			●	●		●	
	EMISSION CONTROLS ON DIESEL ENGINES		●			●		●		●				●			●	●			
RELOCATE TRUCK TRAFFIC FROM REGION	CIRCUMFERENTIAL HIGHWAYS		●			●		●				●			●		●	●	●	●	
EPISODIC CONTROLS	BAN NON-ESSENTIAL TRUCK TRAFFIC		●				●	●		●			●					●	●	●	
CONTROL AIRCRAFT EMISSIONS	REDUCE DEMAND FOR AIR TRAVEL			●		●		●		●			●								
	LIMIT OPERATIONS		●			●		●		●			●								
REDUCE LOW SPEED RUNNING OF AIRCRAFT ENGINES	GROUND MANEUVERS																				
	TOWING																				
	MOBILE LOUNGES																				
REDUCE GROUND EQUIPMENT EMISSIONS	VAPOR RECOVERY DEVICES ON FUEL HANDLING			●				●			●			●			●	●			
	LIMIT GROUND SUPPORT VEHICLES			●		●		●		●			●						●		

CONTROL MEASURES	POLICY INSTRUMENTS	LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS: INTERMEDIA					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
		LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
CONTROLS ON DIESEL & SHIPPING	LAND USE CONTROL	Y	Y	X	X	X	X	X						
REDUCE DEMAND FOR DIESEL AND SHIPPING	TAX POLICY	N	N	X			X	X						
REDUCE EMISSIONS FROM DIESEL ENGINES	EMISSION STANDARDS FOR DIESEL ENGINES	N	Y	X										
	EMISSION CONTROLS ON DIESEL ENGINES	Y	Y	X				-						
RELOCATE TRUCK TRAFFIC FROM REGION	CIRCUMFERENTIAL HIGHWAYS	N	N	X										
EPISODIC CONTROLS	BAN NON-ESSENTIAL TRUCK TRAFFIC	N	Y	X										
CONTROL AIRCRAFT EMISSIONS	REDUCE DEMAND FOR AIR TRAVEL			X				X						
	LIMIT OPERATIONS			X										
REDUCE LOW SPEED RUNNING OF AIRCRAFT ENGINES	GROUND MANEUVERS			X			X							
	TOWING			X			X	X						
	MOBILE LOUNGES			X			X	X						
REDUCE GROUND EQUIPMENT EMISSIONS	VAPOR RECOVERY DEVICES ON FUEL HANDLING	N	Y	X										
	LIMIT GROUND SUPPORT VEHICLES			X			X	X						

Table 39. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS

LIGHT DUTY VEHICLES

SOURCE CATEGORY LIGHT DUTY VEHICLES (LDV) 17% OF HYDROCARBON EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	% EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
REDUCE VEHICLE OWNERSHIP	TAXES, FEES, INSPECTION			●				1.3	NA	3	3	1	-	1	1	1	-	1	1	1	-				●	●			●	●					●			●				Y	Y	X			X	X						1
DIVERT AUTO PASS. TO TRANSIT AND RAIL	IMPROVE SERVICE			●				1.3	NA	1	1	3	-	2	1	1	-	1	1	1	-		●			●		●			●			●			●	●	●	●		Y	N	X			X	X						
	SUBSIDIZE FARES		●					0.6	NA	1	1	3	-	2	1	1	-	1	1	1	-			●		●		●		●			●				●	●				Y	N	X			X	X						
	INCREASE PARKING COSTS	●						0.2	NA	3	3	1	-	1	1	1	-	1	1	1	-			●		●		●		●			●							●		N	Y											
REDUCE NO. OF DRIVERS	AGE OR OTHER RESTRICTIONS	●						0.2	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●				N	Y	X	X		X							2
DECREASE USE OF HIGHWAYS	USER TAXES AND FEES		●					0.6	NA	3	3	1	-	2	1	1	-	1	1	1	-			●		●		●		●				●					●	●	●	Y	Y	X	X		X							
REDUCE AM PEAK PERIOD VMT	4-DAY WORK WEEK			●				1.3	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●					●					●	●	N	Y	X	X		X							
	STAGGERED WORK HOURS			●				1.3	NA	1	1	1	-	2	1	1	-	1	1	1	-			●		●		●		●			●						●	●	●	N	Y	X	X		X							
	CARPOOL LOCATOR	●						0.2	NA	1	1	1	-	2	1	1	-	1	1	1	-				●	●		●		●			●						●	●	●	Y	N	X	X		X							
REDUCE SUMMER VMT	COORDINATE VACATION	●						0.2	NA	1	1	1	-	1	1	1	-	1	1	1	-			●			●		●		●			●					●	●	●	N	Y	X	X	X	X							
	SEASONAL FUEL RATIONING/ ALLOCATION			●				1.3	NA	3	3	1	-	2	1	1	-	1	1	1	-	●					●		●	●			●				●			●		N	Y	X	X	X	X							3
RESTRICT TRAVEL	YEAR ROUND FUEL RATIONING/ALLOCATION				●			3.0	NA	3	3	1	-	2	1	1	-	1	1	1	-	●				●			●	●			●				●			●		Y	Y	X	X	X	X							3
RELOCATE TRAFFIC OUT OF REGION	PROHIBIT THRU TRAFFIC	●						0.2	NA	2	1	3	-	1	1	1	-	1	1	1	-			●		●		●				●				●	●	●	●			Y	N	X	X		X							4

Table 39. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS (Cont.)

LIGHT DUTY VEHICLES

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDER-ATIONS					LEGAL CONSID-ERATIONS		ENVIRON-MENTAL EFFECTS					PUBLIC RESPON-SIVENESS					
LIGHT DUTY VEHICLES (CONTINUED)										DIRECT COSTS				ADMINIS-TRATIVE COSTS				SOCIAL COSTS				FLEXI-BILITY				APPLI-CATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
RESTRICT HIGHWAY CONST. IMPROVEMENTS	WITHHOLD GRANTS FUNDS				●			3.0	NA	1	1	1	-	1	1	1	-	1	1	2	-	●				●		●		●						●	●	●				Y	N	X	X	X	X							
DECREASE USE OF AUTO ACCESSORIES	TAXES DESIGN CRITERIA	●						0.2	NA	3	3	1	-	1	1	1	-	1	1	1	-			●		●		●		●					●			●	●			Y	Y	X										
MODIFY ENGINE TYPE	MANU. SPECIFICATIONS		●					0.8	NA	2	2	1	-	1	1	1	-	1	1	1	-	●				●		●			●				●		●				●	Y	Y	X										
ENCOURAGE OPTIMUM TRAFFIC FLOW	HIGHWAY IMPROVEMENT		●					0.6	NA	1	1	2	-	2	1	1	-	1	1	1	-	●				●			●		●				●		●	●		●		Y	N	X			X							
	CAPACITY RESTRICTIONS	●						0.2	NA	1	1	2	-	2	2	1	-	1	1	1	-	●				●			●	●			●					●		●		Y	N											
INCREASE AUTO OCCUPANCY	PARKING INCENTIVES	●						0.2	NA	1	1	2	-	2	-	-	-	1	1	1	-			●		●		●		●			●						●	●	●	Y	N	X	X		X							
	EXPRESS LANES	●						0.2	NA	1	1	1	-	1	2	1	-	1	1	1	-	●				●		●			●			●			●	●	●	●		Y	N	X	X		X							
	TAXES AND INSURANCE BENEFITS		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●				●			●	●			●	Y	N	X	X		X							
IMPROVE EMISSION CONTROLS	FEDERAL SPECIFICATIONS		●					0.6	NA	2	2	1	-	1	1	1	-	1	1	1	-	●				●			●	●					●		●	●				Y	N	X										
ALERT CONTROL OF VMT	BANS ON NON-ESSENTIAL TRAFFIC					●		6.4	NA	2	2	2	-	2	2	[illegible]	-	2	1	1	-		●				●		●	●			●						●	●		Y	N	X	X		X							
	STICKER ELIGIBILITY SYSTEM				●			3.0	NA	1	1	1	-	2	2	1	-	1	1	1	-				●		●	●		●			●						●	●		Y	N	X	X		X							
	EMERGENCY HOLIDAYS		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●								●	Y	N	X	X		X							

Table 40. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS
HEAVY DUTY VEHICLES

SOURCE CATEGORY HEAVY DUTY VEHICLES (HDV) 42% OF HYDROCARBON EMISSIONS		PERCENTAGE RANGE OF EFFECTIVENESS						% EMISSION REDUCTION	ug/m^3 IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDER-ATIONS					LEGAL CONSID-ERATIONS		ENVIRON-MENTAL EFFECTS					PUBLIC RESPON-SIVENESS					REFER TO REMARKS SECTION
										DIRECT COSTS				ADMINIS-TRATIVE COSTS				SOCIAL COSTS				FLEXI-BILITY				APPLI-CATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
REDUCE TRUCK OWNERSHIP	TAXES, FEES, INSP.	●						0.4	NA	3	3	1	-	1	1	1	-	1	1	1	-			●		●		●		●				●				●				Y	Y	X	X		X							1
REDUCE GASOLINE TRUCK OWNERSHIP	TAXES, FEES	●						0.4	NA	3	3	1	-	1	1	1	-	1	1	1	-			●		●		●		●					●			●				Y	Y	X										1
PROHIBIT TRUCK MOVEMENT	TRUCK-FREE ZONES	●						0.4	NA	2	1	1	-	1	1	1	-	1	1	2	-		●			●		●		●			●						●	●		Y	N	X	X		X							
	PUBLIC TRANSIT OF GOODS	●						0.4	NA	2	2	2	-	1	1	1	-	1	1	1	-			●			●	●			●			●					●	●	●	N	N	X	X		X							
REDUCE AM PEAK PERIOD VMT	PROHIBITION		●					1.5	NA	2	2	1	-	1	2	1	-	1	1	2	-	●				●			●	●			●						●	●		Y	N	X	X		X							
	RESTRICTED LOADING ZONES	●						0.4	NA	2	1	1	-	1	1	1	-	1	1	1	-		●				●	●		●			●						●	●		Y	N	X	X		X							
MODIFY ENGINE TYPE	MFG. SPECIFICATION		●					1.5	NA	3	1	1	-	1	1	1	-	1	1	1	-	●				●			●		●					●						Y	Y											
INCREASE USE OF SMALLER VEHICLES	TAX BY WEIGHT				●			3.1	NA	3	2	1	-	1	1	1	-	1	1	2	-		●			●		●		●				●			●	●				Y	Y	X										
IMPROVE EMISSION CONTROLS	FEDERAL AND STATE REGULATIONS						●	31.5	NA	3	1	1	-	1	1	1	-	1	1	1	-	●				●			●			●				●	●	●				Y	N	X										
EPISODIC CONTROL OF VMT	BAN ON NON-ESSENTIAL TRAFFIC				●			7.4	NA	2	2	2	-	2	2	2	-	2	1	1	-		●				●		●	●			●						●	●		Y	N	X		X	X							
	STICKER SYSTEM	●						0.4	NA	1	1	1	-	2	2	1	-	1	1	1	-				●		●	●		●			●						●	●		Y	N	X	X		X							
	EMERGENCY HOLIDAYS	●						0.4	NA	1	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●						●	●		Y	N	X	X		X							

Table 41. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS

LAND USE MEASURES

SOURCE CATEGORY: LAND USE MEASURES		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
		0-2	2-5	5-10	10-25	25-50	50-100	% EMISSION REDUCTION	$\mu g\ m^3$ IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
CONCENTRATE LAND USES IN HIGHER DENSITY CORRIDORS	REVISION OF GENERAL AND ZONING PLAN	●						0.2	NA	1	1	1	-	1	1	1	-	1	1	1	-			●							●				●					●		Y	N	X	X	X	X							
	SPECIAL USE PERMITS	●						0.2	NA	1	1	1	-	1	1	1	-	1	1	1	-		●						●		●					●				●		Y	N	X	X		X							
	FLOATING ZONES	●						0.4	NA	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●						●				●		Y	Y	X			X							
	LARGE LOT ZONING OUTSIDE OF NEW CENTERS	●						0.2	NA	1	2	1	-	1	1	1	-	1	1	1	-		●					●		●			●							●		Y	Y	X			X							
	PUD	●						0.4	NA	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●						●				●		Y	N	X			X							
	AGRICULTURAL AND CONSERVATION ZONES	●						0.4	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●						●				●		Y	N	X			X							
	OPEN SPACE AQUISITION/EASEMENTS	●						0.2	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●		●		Y		X			X							
	HOLDING ZONES	●						0.4	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●						●				●		Y	Y	X			X							
	LAND BANKING	●						0.4	NA	1	1	3	-	2	1	1	-	1	1	1	-			●		●		●		●						●	●			●		Y	Y	X			X							
	TRANSFER OF DEVELOPMENT RIGHTS	●						0.2	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●				●			●							●		Y	Y	X			X							
	TAXATION POLICY	●						0.4	NA	1	1	1	-	2	1	1	-	1	1	1	-		●			●		●		●				●				●		●		Y	Y	X			X							
EXCLUDE HIGH POLLUTANT SOURCES FROM AQMA	REVISION OF GENERAL AND ZONING PLANS		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-			●		●					●					●				●		Y	Y	X	X	X	X							
	EIS/EIR AND A-95 REVIEW		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-			●				●		●				●				●	●	●		Y	N	X	X	X	X							
	INDIRECT SOURCE REVIEW		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-		●					●		●			●				●	●	●	●		Y	Y	X			X							

Table 41. POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS (Cont.)

LAND USE MEASURES

SOURCE CATEGORY LAND USE MEASURES (CONTINUED)		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	%EMISSION REDUCTION	ug/m^3 IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
REGULATE TIMING OF NEW DEVELOPMENT	REVISION OF GENERAL AND ZONING PLAN		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-			●							●				●					●				x	x	x	x							
	DEVELOPMENT DISTRICTS		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-			●		●		●			●				●			●		●				x	x	x	x							
	MORATORIA		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-	●				●		●		●			●					●		●		Y	Y	x	x	x	x							
	LAND BANKING		●					0.6	NA	1	1	3	-	2	1	1	-	1	1	1	-			●			●	●		●				●				●		●				x			x							
	109 J REVIEW		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-			●				●		●			●				●	●				Y	N	x	x		x							
	TAX POLICY		●					0.6	NA	1	1	3	-	2	1	1	-	1	1	1	-		●				●		●	●					●			●		●				x	x		x							
	CAPITAL IMPROVEMENTS PROGRAMMING		●					0.6	NA	1	1	1	-	1	1	1	-	1	1	1	-		●			●			●	●				●						●		Y	Y	x	x	x	x							

REMARKS

The numbered remarks presented in this section correspond to the numbered notations contained in the remarks column for the matrix tables. The applicable table number is referenced in parentheses following the heading.

Industrial Processing and Heating (Table No. 32)

(1) It is a function of the number of new sources to which it is applied.

Power Plants (Table No. 33)

(1) Storage of clean fuel could be stockpiled for utilization during periods of alert. Development of new generating sources such as water pump storage is required.

(2) Increasing actual stack height would in effect change the effective stack height.

(3) Prediction of alerts is a necessary step to implementing this measure.

Fugitive Dust (Table No. 35)

(1) Government grants for research and development would be necessary to stimulate industry to seek alternative designs.

(2) Assumes particulate dispersion occurring.

Land Use Measures, Stationary (Table No. 36)

(1) These two control measures present different degrees of the same measure, prohibiting the introduction of new sources where standards will be exceeded. Since particulates are a localized problem it's possible to limit new sources at selected location.

(2) Assumption: Standards are attained; use of these controls to maintain standard during 10 year growth period.

(3) This measure refers to (1) economies of scale if several small sources can combine part of their processes and share control costs, (2) reducing space heating and energy demands through attached units and modular integrated utility systems.

(4) Rapid amortization of obsolete or ineffective equipment can make the introduction of control equipment more economically feasible.

(5) These measures postpone the introduction of new sources until (1) control technology improves, (2) emissions from other sources decrease.

Light Duty Vehicles (Table No. 39)

(1) Rapid amortization of obsolete or ineffective equipment can make the introduction of controls on vehicle ownership feasible.

(2) The discriminatory nature of this measure makes its implementation doubtful.

(3) Fuel rationing should be looked at as a measure of last resort. The expensive nature of initiating a rationing program must be considered.

(4) Assumption being that implementation can be postponed until the time that mass transportation is installed.

Heavy Duty Vehicles (Table No. 40)

(1) Rapid amortization of obsolete or ineffective equipment can make the introduction of control equipment more economically feasible.

CHAPTER IX

DESIGN AND SELECTION OF STRATEGIES

INTRODUCTION

Having selected, categorized and evaluated individual control measures for particulates and hydrocarbons, as discussed in Chapter VII and presented in Chapter VIII, the process of designing an air quality maintenance plan remains. Theoretically, any number of alternate particulate and hydrocarbon control strategies could be designed by combining mixes of various control measures to achieve the desired air quality. However, realistically certain measures are not compatible and should not be included in the same plan. Of prime importance for the inclusion of a control measure in a plan is the degree of effectiveness in reducing emission levels and the social, economic, public or political implications associated with that measure. Applying these general rules to the strategy designing process limited the number of plans that could evolve.

The remainder of this chapter will discuss the three alternative hydrocarbon and particulate control strategies that were designed to maintain air quality through the year 1985. In the interest of clarity the hydrocarbon and particulate plans will be presented separately. A final plan is presented and the social, economic, political impacts discussed.

HYDROCARBONS

The foremost criterion used in the design of alternative hydrocarbon control strategies for discussion with the Baltimore Regional Planning Council Air Quality Task Force and with local agencies was meeting the required reduction in hydrocarbon emissions during the three hour morning peak period from 6:00-9:00 a.m. During this period, it is forecast that 24.35 tons of hydrocarbons will be emitted from all sources in 1985, after the Baltimore Transportation Control Plan is in effect (see Table 22, Chapter V). The reduction required to achieve the allowable emissions (see Table 26, Chapter V) is 6.05

tons/peak period. This represents a 24.8 percent reduction in hydrocarbon emissions in the three hour period.

Three separate strategies for attaining the required reduction were developed, each aimed primarily at one of the three principal sources of hydrocarbon emissions: heavy duty vehicles (41.5 percent of the 1985 emissions), light duty vehicles (16.83 percent) and industrial solvents other than dry cleaning (16.59 percent). These are described below.

Alternative Hydrocarbon Plan Number 1

The largest source category, heavy duty vehicles (HDV), was examined as the basis for the first plan. Since HDV's will contribute 41.5 percent of the hydrocarbon emissions in 1985, a 59.9 percent reduction in projected emissions from this source could reduce area-wide hydrocarbon emissions to acceptable levels (41.5 percent x 59.9 percent = 24.86 percent). Through an examination of the "shopping list" of control measures for HDV, the most logical measure can easily be determined. The imposition of emission controls on HDV, if 75 percent effective, will reduce total projected hydrocarbon emissions by 31.5 percent. The public acceptability of this measure can be expected to be generally good, though the business community and those whose interests are tied to the trucking industry could have an adverse reaction.

Alternative Hydrocarbon Plan Number 2

The second plan for hydrocarbon emission controls places the emphasis on the control of a group of transportation oriented sources. The majority of the measures address light duty vehicles (LDV) and HDV with some control of industrial hydrocarbon solvents and aircraft. The control measures and policy instruments are as follows:

(1) Restrict highway construction and improvements by withholding funds.

(2) Divert auto passengers to rail and bus by improving service, subsidizing fares, user taxes and land use controls to concentrate development into transportation corridors using revisions to the general and zoning plan, use permits, floating zones, agricultural and conservation zones, holding zones, land banking, planned unit development and tax policies.

(3) Reduce AM VMT by staggering working hours.

(4) Increase auto occupancy by the institution of carpool incentives such as reduced parking rates, opening bus express lanes to carpools and tax/insurance rate reductions.

(5) Reduce the use of accessories through taxation or the imposition of fees for use of major accessories.

(6) Improve emission controls for LDV through stricter Federal regulations.

(7) Prohibit truck movements by the use of truck-free zones and the use of transit vehicles to move selected goods.

(8) Reduce AM truck VMT through a selective ban on AM truck use.

(9) Increase the use of smaller trucks (LDV) rather than heavy duty vehicles, through taxes and fees.

(10) Reduce the use of hydrocarbon solvents (other than dry cleaning) by the imposition of taxes and fees.

(11) Reduce aircraft emissions by freezing the number of aircraft operations at BWI Airport.

Measures 2 (excepting land use controls), 3, and 4 above will have one level of effectiveness (that described in the matrix) when used without Measure 1, and a lesser level of effectiveness when combined with Measure 1. On the other hand, the effectiveness of the land use controls in Measure 2 will be enhanced when used in conjunction with transit improvements, fare subsidies and carpool incentives. The probable degree of effectiveness has been reassessed accordingly.

Application of all of the above measures will produce an estimated reduction in forecast peak period VMT of 30 percent.

It must be recorded that a number of the above measures can be expected to have a low level of public acceptability (refer to matrix), more particularly those which directly affect the out-of-pocket expenses and driving habits of the automobile driving public. In addition, the range and diversity of the measures will make the administration of this plan complex.

Alternative Hydrocarbon Plan Number 3

The thrust of this plan is to concentrate controls on industrial hydrocarbon solvents other than those used in dry cleaning processes. Control of the latter is already proposed as part of the control strategy. A total ban on the use of the remaining solvents would not alone bring about the required reduction, calling for the application of selected transportation related measures in support of the main measure. Those transportation measures were used which have the highest level of effectiveness, though excluded was the restriction on the construction and improvement of the region's highways. The plan consists of the following measures:

(1) Reduce use of hydrocarbon solvents by banning their use other than from a very limited number of individual exceptions.

(2) Reduce AM HDV VMT through a selective ban on truck movements.

(3) Increase the use of smaller trucks (LDV) rather than heavy duty vehicles by the imposition of taxes by weight.

(4) Divert auto passengers to rail or bus by improving transit service.

(5) Reduce AM LDV VMT by staggering work hours.

(6) Reduce aircraft emissions by freezing the number of aircraft operations at BWI Airport.

The plan assumes that the ban on solvents would be 75 percent effective and takes full credit for reduced VMT through improved transit service. The public acceptability of this plan would be dependent largely on the ability of industry to adapt coating processes to the ban on hydrocarbon solvents. Although numerous coating substitutes for the oil based products are available, under current technology the quality may not be as high. If the quality of the new process is within expectations, then this plan could be acceptable to the public.

SELECTION OF TRIAL HYDROCARBON STRATEGY

The three alternative hydrocarbon control strategies were presented to the RPC's Air Quality Task Force to test public reaction to each and the individual measures included in each. The alternatives were subsequently discussed with regional and state agency staff.

The reaction of the citizens, business representatives and agency representatives on the Task Force was one of overwhelming support for Plan Number 1. The participants at the meeting approved of the simplicity of the plan, having one principal element, and of its probable public acceptance. A suggestion which resulted from the task force meeting was that being a state plan, the range of effectiveness should be measured assuming state regulation rather than Federal regulation of heavy duty vehicle hydrocarbon emissions.

In considering this suggestion, it was noted that air/fuel retrofit of HDV, air/fuel retrofit of pre-1974 MDV, and catalytic retrofit of 1971-1974 MDV were part of the Transportation Control Plan (see Chapter V). Rather than the 30 percent effectiveness for HDV air/fuel assigned by 38FR34245, a greater effectiveness could likely be achieved. Furthermore, the addition of a catalytic retrofit program could reduce the hydrocarbon emissions of HDV. Beyond these two steps, modifications by the manufacturer must be imposed. It is, therefore, estimated that a 50 percent reduction in hydrocarbon emissions could be achieved beyond that included in the Transportation Control Plan. Although a state regulation action by the Federal Government would be required for the Baltimore Air Quality Control Region to comply with 40 CFR 51.12(g).

This left a balance of 4.09 percent reduction in emissions to be attained from other measures. As described earlier in Chapter IX, light duty vehicles producing 16.83 percent of the 1985 emissions and industrial solvents producing 16.59 percent, are the largest residual hydrocarbon sources by 1985 and appear the most logical targets for such action. Because of the likely public acceptance, industrial solvents were included as an element of the trial plan. This would require a selective ban or other control on the use of hydrocarbon solvents in industrial processes such as degreasing or surface coating. A 25 percent reduction in the emissions from hydrocarbon solvents would reduce emissions 4.14 percent, thus achieving the required reduction.

The reduction in hydrocarbons through control of solvents is included in the plan in preference to the series of land use and transportation measures described in Alternative 2 for reasons that were spelled out, namely administrative complexity and low degree of public acceptance of measures which cut into existing lifestyles and development patterns. The study team wishes to record here that because of the political implications of these measures, we have recommended a plan which does not frontally attack the source of hydrocarbon problems, this being the major dependence of the American public on travel and especially on the use of the private automobile. The long-term solutions to air quality problems and environmental problems in general does, it is believed, depend upon changes in lifestyle which will become politically realistic in the Baltimore Region only when a broader, national commitment to change is obtained. The implications of this alternative approach should be fully understood, if only to assist in public understanding of the rationale for the preferred plan.

Appendix G presents the potential impacts of transportation and land use measures presented in both the hydrocarbon and particulate alternative plans.

Interim Measures to Maintain Standards 1975 through 1985

The trial plan was developed using projected 1985 data. But to be fully responsive to Federal requirements, the plan must also maintain standards through the intermediate years 1975 to 1985. The plan, as described, was therefore evaluated for 1980 under the following assumptions:

(1) The HDV retrofit would be in effect by 1980 thus reducing HDV hydrocarbon emission by 50 percent in 1980.

(2) The industrial solvent controls would be in effect by 1980, thus reducing hydrocarbon emissions by 25 percent in 1980.

Applying these assumptions to the forecast 1980 emissions (see Table 24, Chapter V), the emission reduction attained would fall 3.9 percent (.976 tons) short of the 26.9 percent (6.75 tons) reduction required for 1980.

It is proposed that a group of interim measures, those which can be imposed and lifted without excessive disruption, be used to take up the slack through the middle years of the planning period. These are as follows, with an indication of estimated reduction in tons per a.m. peak period which could be achieved with each in 1980:

Stagger working hours	0.449 tons
Establish truck-free zones	0.095 tons
Selective ban on truck movements in peak a.m. period	0.334 tons
Limit aircraft operations at BWI Airport	0.130 tons

The sum of these measures will produce a 4 percent reduction of hydrocarbon emissions in the a.m. peak period and will maintain Federal standards through the planning period.

There is one other advantage attached to these procedures. If, on periodic review, the measures included in the 1985 plan are found to be not achieving desired results, the interim measures may be extended until the plan proper is effective.

IMPACTS OF THE TRIAL PLAN

Legal Impacts

The central legal issue raised by the plan proposal for installation of emission control devices on heavy duty vehicles is that of the proper level of legal authority. State regulations for emission control on all licensed trucks in Maryland could be implemented. But because the Baltimore region lies within a heavily travelled truck corridor and is close to other states, Federal support for the regulations would be required if the measure is to be effective. Otherwise, non-conformance on the part of out-of-state vehicles would render the measure of limited effectiveness.

Economic and Social Impacts

The social consequences of implementing emission controls on heavy duty vehicles will be small. The increased purchase price of commercial trucks would probably be passed on to customers of truck delivered products and services, although the pass-through on product costs is likely to be minimal given the capacity and utility of trucks on a year-round basis and the modest increase in truck costs with emission control devices (maximum of $500 per vehicle). For those non-business truck owners, the burden of this additional cost will be weighed at initial purchase and no doubt compared with other vehicles which might serve the same purpose for less cost (i.e., LDV).

Similarly, the emission controls or selective ban on hydrocarbon solvents required to achieve a 25 percent reduction in emissions from that source would be small. Any increase in prices which might occur from process changes would be passed on to the customer and although the cost to the polluter may be substantial, when distributed to the consuming public, effects will be minimal.

Other Environmental Effects

The measures in the hydrocarbon control plan will, as a secondary effect, reduce other pollutants from HDV. The heavy duty retrofit program will bring about appreciable reductions in NO_X and SO_2.

PARTICULATE

The primary criterion used in the design of alternative particulate control strategies for the Baltimore AQMA was meeting the required 20 $\mu g/m^3$ reduction in the 1985 projected particulate air quality (see Chapter III for the analysis). It was readily apparent that because of the potentially significant reductions, certain emission categories, such as fugitive dust would be required for each plan in order to achieve the 20 $\mu g/m^3$ reduction.

Each plan attempted to approach the problem in a different manner in order to present a range of choices. The plans were then presented to the Air Quality Task Force for comment. The resulting Particulate Trial Plan reflects the thoughts and comments received at that meeting.

Alternative Particulate Plan Number 1

The first plan represents an attempt at controlling emissions from the Domestic and Commercial, Transportation and the Fugitive Dust categories utilizing a total of fourteen measures. Several of the measures having significant effects in improving air quality levels were also expected to have significant political impacts; however, these were included in order to complete the plan and to allow for a wider choice in strategies.

The control measures and policy instruments included in this plan are as follows:

(1) Improve domestic and commercial building insulation by revising building codes.

(2) Control room temperatures (air conditioning and heating) by public relation campaigns.

(3) Improve design of furnaces for commercial and domestic combustion units.

(4) Improve maintenance programs for domestic and commercial heating/cooling systems by promulgating new regulatory codes.

(5) Convert domestic and commercial heating units to clean fuel (gas, fuel oil, electricity).

(6) Improve attractiveness of non-automobile mode of travel through grants or ridership subsidy.

(7) Restrict highway availability by withholding grant funding in an attempt to reduce particulate emissions from VMT.

(8) Develop and install control devices to control particulates emitted by automobiles. This measure could be implemented by the Federal Government through regulations.

(9) Modify auto/truck tire and brake wear by changing the design specifications on a Federal level.

(10) Eliminate unpaved or poorly paved parking lots through local ordinances or tax incentives.

(11) Eliminate uncovered vacant lots (undeveloped, or sites scheduled for construction sometime in the not immediate future), by planting ground cover sponsored by grants, subsidies and required by local ordinances.

(12) Control dust from construction sites by passing local ordinances.

(13) Control fugitive dust from open bodied vehicles through local ordinances.

(14) Control soil deposition (which is converted to fugitive dust after drying) by implementing such practices as truck washing.

It is estimated that Plan Number 1 will result in a 20.2 $\mu g/m^3$ reduction of the predicted 1985 particulate concentration.

Included in this strategy were measures with similar goals; therefore three instances the estimated improvement in air quality was modified to reflect the overlapping concepts of the individual control measures. These were noted with an asterisk. For instance, the estimated improvement in air quality due to implementing a campaign to improve furnace design, measure No. 3., was 1.1 $\mu g/m^3$, when considered separately but modified to 0.5 $\mu g/m^3$ when considered in conjunction with improved building insulation. A well insulated building will require less heat (and less use of furnace); therefore, the impact of a more efficient and lower polluting furnace is lessened. Similar arguments can be made concerning overlapping control measures designed for or dependent on reduced VMT (measure No. 6. and 8). Over 50 percent of the air quality reduction is due to fugitive dust type measures, with the remaining reduction divided evenly between domestic/commercial heating and transportation controls. While all of the measures are considered to be implementable within a five year period (10 within two years), six measures, accounting for a 6.6 $\mu g/m^3$ reduction, will probably require 5 to 10 or more years before any effect could be realized. As discussed earlier one or two control measures such as restricting highway availability or adding emission control devices to automobiles are very likely to be politically or socially unacceptable.

If implemented as stated, measures 2, 4, 6, and 7 would affect the lifestyle of the average Baltimore citizen in his home and would have an even greater impact on his commuting habits. In general, the impact of the remaining measures will largely be economic in nature and will affect the inhabitants of the AQMA either directly or indirectly in their consumption of goods and services.

Alternative Particulate Plan Number 2

Plan Number 2 enlisted eight measures involving land use, transportation and fugitive dust controls to achieve the required 20 $\mu g/m^3$ reduction in predicted 1985 particulate concentrations. As with Plan Number 1 this strategy contains measures which may be politically unacceptable. In general the plan is not as specific as Plan Number 1 since the land use and transportation measures, which represent a significant portion of the total reduction, are designed to ultimately modify the existing patterns through rezoning and urban renewal.

The control measures and policy instruments included in this plan are as follows:

(1) Excluding new sources from selected high pollution areas by revising the general zoning plan.

(2) Controlling existing land uses through redevelopment incentives, urban renewal programs.

(3) Restrict highway availability by withholding grant funding in an attempt to reduce particulate emissions from VMT.

(4) Reduce demand for transportation, agriculture and other activities in order to reduce fugitive dust. This could possibly be accomplished through a taxation policy.

(5) Control dust from construction sites by passing local ordinances.

(6) Control fugitive dust from open bodied vehicles through local ordinances.

(7) Control soil deposition (which is converted to fugitive dust after drying) by implementing such practices as truck washing.

(8) Cover over vacant lots with grass or vegetation through local ordinances.

It is estimated that Plan Number 2 will result in a 20.0 $\mu g/m^3$ reduction of predicted 1985 particulate concentration.

As in Plan Number 1, this plan contains measures which overlap in concept. The effectiveness of Measures Number 1, 4, 7 and 8 were modified downward to reflect this situation. Plan Number 2 also relies heavily on fugitive dust control as a basic strategy (approximately 55 percent of the reductions), with land use measures accounting for 35 percent and transportation 10 percent. All of the measures can probably be implemented within a five year period, however, three measures will probably require from 5-10 years before their effectiveness would be realized. One of these three longer term measures is the control of existing land uses which represents the single largest source of reductions. Although it does not attack a specific source it can be designed to affect specific areas in the region.

If implemented as stated, measures 1 through 3 would ultimately affect development in the Baltimore region. The remaining measures dealing with fugitive dust, are more source specific and would probably exhibit secondary economic effects.

Alternate Particulate Plan Number 3

Plan Number 3 is designed to control emissions primarily by controlling area type sources utilizing equipment modifications and "black boxes." As with the two previous plans this plan also includes controls in the fugitive dust sources.

The control measures and policy instruments included in Plan Number 3 are as follows:

(1) Install control devices on small combustion units by changing local regulations or improving design specifications.

(2) Improving the furnace design of domestic and commercial units by improving on specifications.

(3) Improving maintenance programs of heating systems by implementing new codes.

(4) Using smaller auto engine to weight ratios through increased taxation

(5) Control of fugitive dust from construction sites by passing local ordinances.

(6) Control of fugitive dust from open bodied vehicles by passing local ordinances.

It is estimated that Plan Number 3 will result in a 19.8 $\mu g/m^3$ reduction of the predicted 1985 particulate concentration.

The largest single contributor to this reduction is the installation of control devices on small combustion units, which will probably be the least politically acceptable to the general public. It represents 50 percent of the desired reduction. In addition, this measure will be costly and difficult to implement (both the initial installation and follow-on maintenance). The remaining measures have been presented in Plans Number 1 and 2. Plan Number 3 therefore relies heavily on traditional air pollution engineering to reduce residual emission from existing controlled or uncontrolled sources as compared to land use and transportation strategies found in Plans Number 1 and 2.

SELECTION OF TRIAL PARTICULATE STRATEGY

In the development of the three alternative strategies it quickly became apparent that without stringent control of fugitive dust and courageous measures in the area of land use and transportation planning, NAAQS could not be maintained. The three plans and this conclusion were presented to the RPC's Air Quality Task Force. The panel supported all of the fugitive dust control measures and indicated tacit approval of those measures directed at the conservation of energy, e.g., improved insulation and furnace design. In the area of land use and transportation planning no consensus could be reached, although the necessity for air pollution considerations in such planning was admitted. For the reasons discussed in the selection of the trial hydrocarbon strategy no significant measure was directed at the control of automobile ownership and use, although the direct reduction in particulate emissions from this source category and the secondary reductions in fugitive dust from automobile associated activity will have to be considered as vulnerable points of attack in the future.

The selected land use measures which are included in the strategy are considered those most nearly acceptable to the panel. Effectiveness of the measures, probably not apparent before the last half of the decade, will depend on the vigor of the Air Quality Task Force in implementing the principle of land planning as a tool in the control of air pollution.

The selected strategy is a hybrid of the three candidate strategies and includes elements from each. The measures can be categorized and listed as follows:

Measures to Control Fugitive Dust

(1) Control construction sites
(2) Control open bodied vehicles
(3) Control deposition on roads
(4) Modify tire and brake wear design

Measures to Reduce Energy Consumption

(1) Improve maintenance of heating systems
(2) Improve furnace design
(3) Improve building insulation
(4) Control room temperatures

Land Planning Measures

(1) Exclude new sources from hot spots

(2) Change existing land use

Detailed evaluation of the measures is shown on Table 49.

Impacts of the Trial Plan

Legal Impacts - Legal precedent, both in the form of air pollution control and prevention of a general nuisance, exists to regulate emissions from the first three fugitive dust sources. New, specific rules will have to be formulated and approved. The same issue as that for control of hydrocarbons from HDV is raised in an attempt to modify tire and brake design.

Legal implications of the energy conservation measures include the limitation on authority of local authorities; however, there is no reason to consider these measures legally not implementable. The most difficult aspect is in enforcement. In actual operation these measures will finally respond only to the economic advantage of energy conservation brought on by increased fuel costs.

Land use measures are currently within the purview of local and regional zoning authorities. Refer to Appendix G for additional comments.

Economic and Social Impacts - The strategy selected tends to minimize social and economic impacts by the very nature of the selection process. The measures directed at fugitive dust control will have very modest cost to the consumer; those directed at conservation of energy will, after the moderate capital investment involved, eventually result in a net benefit to society. The land use measures, if implemented over the decade as sources of emissions are normally retired, will involve no cost, provided equally attractive industrial sites are provided for the new installations.

Other Environmental Effects - None of the measures selected for the trial plan have a negative impact on other pollutants. All have a positive effect in reducing other air pollutants.

Timing - A review of the particulate trial plan reveals that five of the ten control measures will have an impact on air quality within two years. One control measure will have an impact on air quality in the two-five year time frame. Taken together these six control measures will reduce air quality levels by

11.1 $\mu g/m^3$ by 1980. The projected air quality for 1980 without controls would be about 77 $\mu g/m^3$ (Chapter III). By substraction then, the 1980 air quality level will be about 66 $\mu g/m^3$ with the control measures. To achieve the NAAQS earlier than 1985 will require either additional control measures or more stringent application of the listed measures. Otherwise the standard will not be fully achieved until the year 1985.

Table 42. ALTERNATE HYDROCARBONS PLAN NO. 1

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS						% EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					REFER TO REMARKS SECTION
CONTROL MEASURES	POLICY INSTRUMENTS									DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
		0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGR/ MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
IMPROVE EMISSION CONTROLS (HDV)	FEDERAL AND STATE REGULATIONS						●	31.5	-	3	1	1	-	1	1	1	-	1	1	1	-	●				●			●			●				●	●	●				Y	N	X				-						
	TOTAL IMPROVEMENT							31.5																																														

Table 43. ALTERNATE HYDROCARBONS PLAN NO. 2

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	% EMISSION REDUCTION	ug/m^3 IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
RESTRICT HIGHWAY CONST IMPROVEMENTS	WITHHOLD FUNDS				●			3.0		1	1	1	-	1	1	1	-	1	1	2	-	●				●		●		●				●			●	●				Y	N	X	X	X	X	X						
DIVERT AUTO PASS TO TRANSIT AND RAIL	IMPROVE SERVICE			●				0.5*		1	1	3	-	2	1	1	-	1	1	1	-		●			●		●			●			●			●	●	●	●		Y	N	X			X	X						
	SUBSIDIZE FARES		●					0.2*		1	1	3	-	2	1	1	-	1	1	1	-			●		●		●		●			●				●	●				Y	N	X			X	X						
	USER TAXES		●					0.1*		3	3	1	-	2	1	1	-	1	1	1	-			●		●		●		●				●				●	●	●		Y	Y	X			X	X						
	REVISE GENERAL AND ZONING PLAN	●						0.4*		1	1	1	-	1	1	1	-	1	1	1	-			●		●		●			●					●				●		Y	Y	X	-	-	-	X						
	USE PERMITS	●						0.4		1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●						●				●		Y	Y	X	-	-	-	X						
	FLOATING ZONES	●						0.4		1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●						●				●		Y	Y	X	-	-	-	X						
	AGRICULTURAL CONSERVATION ZONES	●						0.4		1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●						●				●		Y	Y	X	-	-	-	X						
	HOLDING ZONES	●						0.4		1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●						●				●		Y	Y	X	-	-	-	X						
	LAND BANKING	●						0.4		1	1	3	-	1	1	1	-	1	1	1	-			●		●		●		●						●				●		Y	Y	X	-	-	-	X						
	P.U.D.	●						0.4		1	1	1	-	1	1	1	-	1	1	1	-			●		●		●		●						●				●		Y	N	X	-	-	-	X						
	TAX POLICIES	●						0.4		1	1	1	-	2	1	1	-	1	1	1	-		●			●		●		●				●			●			●		Y	Y	X	-	-	-	X						
REDUCE AM VMT	STAGGER WORK HOURS			●				0.9*		1	1	1	-	2	1	1	-	1	1	1	-			●		●		●		●			●						●	●	●	N	Y				X							
INCREASE AUTO OCCUPANCY	CAR POOL INCENTIVES	●						0.2		1	1	1	-	2	1	1	-	1	1	1	-			●			●		●	●			●				●	●	●	●		Y	N	X			X	X						

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN

Table 43. ALTERNATE HYDROCARBONS PLAN NO. 2 (CONTINUED)

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	% EMISSION REDUCTION	ug/m^3 IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
REDUCE USE OF ACCESSORIES	TAXES FEES	●						0.2		3	3	1	-	1	1	1	-	1	1	2	-		●			●		●		●					●			●	●			Y	●					X						
IMPROVE EMISSION CONTROLS (LDV)	FEDERAL REGULATIONS		●					0.8		3	3	1	-	1	1	1	-	1	1	2	-	●				●			●	●					●		●	●				Y	Y					-						
PROHIBIT TRUCK MOVEMENTS	TRUCK-FREE ZONES	●						0.4		2	1	1	-	1	2	1	-	1	1	1	-		●			●		●		●			●						●	●		Y	N	X	X		X							
	MOVE GOODS BY TRANSIT	●						0.4		1	1	2	-	1	1	1	-	1	1	1	-			●			●	●			●			●					●	●	●	N	N	X	X		X							
REDUCE AM TRUCK VMT	SELECTIVE BAN		●					1.5		2	2	1	-	1	2	1	-	1	1	2	-	●				●			●	●			●						●	●		Y	N	X	X		X							
INCREASE THE USE OF SMALLER TRUCKS	TAX BY WEIGHT			●				3.1		2	2	1	-	1	1	1	-	1	1	2	-		●				●	●		●						●	●	●				Y	Y	X			X	X						
REDUCE USE OF HC SOLVENTS	TAXES FEES					●		6.4*		3	2	1	-	2	2	1	-	1	1	2	-		●				●	●		●				●			●	●		●		Y	Y											
REDUCE AIRCRAFT EMISSIONS	NO GROWTH IN BWI FLIGHTS							1.8		3	2	1	-	1	1	1	-	1	1	1	-	●				●		●		●			●				●	●				Y	N				X	X						
REDUCTION IN EMISSIONS FROM GASOLINE STORAGE AND HANDLING VIA REDUCED VMT								.4		1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●					●			●	●	●								X						
	TOTAL IMPROVEMENT							23.9																																														

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN

Table 44. ALTERNATE HYDROCARBONS PLAN NO. 3

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDER-ATIONS					LEGAL CONSID-ERATIONS		ENVIRON-MENTAL EFFECTS					PUBLIC RESPON-SIVENESS					
										DIRECT COSTS				ADMINIS-TRATIVE COSTS				SOCIAL COSTS				FLEXI-BILITY				APPLI-CATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	% EMISSION REDUCTION	ug m^3 IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
REDUCE USE OF HC SOLVENTS	BAN ON HC SOLVENTS						●	12.8		3	2	1	–	1	2	1	–	1	1	2	–	●				●			●	●				●			●	●	●	●		Y	Y											
REDUCE AM TRUCK VMT	SELECTIVE BAN		●					1.5		2	2	1	–	1	2	1	–	1	1	2	–	●				●			●	●			●						●	●		Y	N	X	X		X							
INCREASE THE USE OF SMALLER TRUCKS	TAX BY WEIGHT			●				3.1		3	2	1	–	1	1	1	–	1	1	2	–		●			●		●		●						●	●	●				Y	Y	X			X	X						
DIVERT AUTO PASS TO TRANSIT AND RAIL	IMPROVE SERVICE			●				1.3		1	1	3	–	2	1	1	–	1	1	1	–		●			●		●			●			●			●	●	●	●		Y	N	X			X	X						
REDUCE AM VMT	STAGGER WORK HOURS			●				1.3*		2	2	1	–	1	2	1	–	1	1	2	–			●		●		●		●			●					●	●	●	●	Y	N	X				X						
REDUCE AIRCRAFT EMISSIONS	NO GROWTH IN BWI FLIGHTS							1.8		3	2	1	–	1	1	1	–	2	2	1	–	●				●		●		●			●				●	●				Y	N				X	X						
	TOTAL IMPROVEMENT							21.6																																														

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN

Table 45. THE TRIAL HYDROCARBON PLAN

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	% EMISSION REDUCTION	$\mu g\ m^3$ IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
IMPROVE EMISSION CONTROLS (HDV)	FEDERAL AND STATE REGULATION						50	20.8*	-	3	1	1	-	1	1	1	-	1	1	1	-	●				●			●			●				●	●	●				Y	N	X				-						
REDUCE USE OF HC SOLVENTS	BAN ON HC SOLVENTS					25		41.1		3	2	1	-	1	2	1	-	1	1	2	-	●				●			●	●				●			●	●	●	●		Y	Y											
	TOTAL IMPROVEMENT							24																																														

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN

Table 46. ALTERNATE PARTICULATE PLAN NO. 1

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDER-ATIONS					LEGAL CONSID-ERATIONS		ENVIRON-MENTAL EFFECTS					PUBLIC RESPON-SIVENESS					
										DIRECT COSTS				ADMINIS-TRATIVE COSTS				SOCIAL COSTS				FLEXI-BILITY				APPLI-CATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	%EMISSION REDUCTION	ug/m³ IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
IMPROVE DOMESTIC AND COMMERCIAL BUILDING INSULATION	BUILDING CODES			●					1.1	1	2	1	-	1	1	1	-	1	1	1	-	●				●		●		●					●					●		Y	Y	X			X	X						
CONTROL ROOM TEMP. FOR A C & HEATING	ADVERTISING			●					1.1	1	2	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●				●	●	●	●	●	Y	N	X				X						
IMPROVE FURNACE DESIGN	IMPROVE DESIGN SPECS.			●					0.5*	2	2	1	-	1	1	1	-	1	1	1	-	●				●		●			●				●		●				●	N	Y	X				X						
IMPROVE MAINTENANCE OF HEATING SYSTEM	REGULATORY CODE			●					1.1	1	2	1	-	1	1	1	-	1	1	1	-			●			●	●		●			●							●	●	Y	Y	X				X						
CONVERT TO CLEAN FUEL	TAX POLICY						●		0.8	2	2	1	-	1	1	1	-	1	1	1	-										●				●		●	●		●	●	Y	Y	X	X	X								
IMPROVE ATTRACTIVENESS OF NON-AUTO MODES OF TRAVEL	GRANTS, SUBSIDIES	●							0.2*	1	1	2	-	2	1	1	-	1	1	1	-			●		●		●			●				●		●	●		●		Y	Y	X										
RESTRICT HIGHWAY AVAILABILITY	WITHHOLD GRANTS FUNDS				●				2.2	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●					●			●		●		N	Y	X										
ADD EMISSION CONTROL DEVICES TO AUTO.	FEDERAL SPECIFICATIONS				●				2.0*	1	2	1	-	2	2	2	-	1	1	1	-		●			●			●		●				●		●	●	●	●		Y	Y	X										
MODIFY TIRE AND BRAKE WEAR DESIGN	DESIGN SPECS. FOR GREATER DURABILITY		●						0.7	2	2	1	-	1	1	1	-	1	1	1	-		●			●		●		●				●			●				●	N	Y	X										
ELIMINATE UNPAVED PARKING LOTS	LOCAL ORDINANCES TAX INCENTIVES		●						0.7	3	2	1	-	1	1	1	-	1	1	1	-		●			●		●		●			●					●		●		Y	Y	X										
PLANT GROUND COVER ON VACANT LOTS	LOCAL ORDINANCES GRANTS, SUBSIDIES			●					1.5	1	1	1	-	1	1	1	-	1	1	1	-				●	●		●		●			●							●	●	Y	Y	X										
CONTROL CONSTRUCTION SITES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●					●		●		Y	N	X										
CONTROL OF OPEN BODIED VEHICLES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	2	1	-	1	1	1	-	●				●			●	●			●							●		Y	Y	X										
CONTROL OF DEPOSITION ON ROADS	LOCAL ORDINANCES				●				1.5*	2	1	1	-	1	2	1	-	1	1	1	-		●			●		●		●			●							●		Y	Y	X										
	TOTAL IMPROVEMENT								[illegible].2																																													

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN.

Table 47. ALTERNATE PARTICULATE PLAN NO. 2

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS								ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS				FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100	%EMISSION REDUCTION	ug m^3 IMPROVED AIR QUALITY	TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
EXCLUDE NEW SOURCES FROM SELECTED HOT SPOTS	REVISION OF GENERAL ZONING PLAN						●		1.8*	2	1	2	-	2	1	1	-	2	2	2	-			●							●				●					●		Y	N	X	X	X	X	X						
CONTROL OF EXISTING LAND USES	URBAN RENEWAL AND REDEVELOPMENT INCENTIVES		●						5.4	1	2	3	-	3	2	1	-	1	1	1	-			●				●			●				●		●			●		Y	N	X	X	X	X	X						
RESTRICT HIGHWAY AVAILABILITY	WITHHOLD GRANTS FUNDS				●				2.2	1	1	1	-	1	1	1	-	1	1	1	-		●			●		●		●				●				●		●		N	Y	X										
REDUCE DEMAND FOR TRANSPORTATION, AGRICULTURE AND OTHER ACTIVITIES	TAX POLICY			●					1.1*	1	1	1	-	1	1	1	-	1	1	1	-		●				●				●				●		●	●		●		N	Y	X	X		X	X						
CONTROL CONSTRUCTION SITES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●							●		Y	N	X										
CONTROL OF OPEN BODIED VEHICLES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	2	1	-	1	1	1	-	●				●			●	●			●							●		Y	Y	X										
CONTROL OF DEPOSITION ON ROADS	LOCAL ORDINANCES				●				1.5*	2	1	1	-	1	2	1	-	1	1	1	-		●			●		●		●			●							●		Y	Y	X										
PLANT GROUND COVER ON VACANT LOTS	LOCAL ORDINANCES SUBSIDIES		●						1.0*	1	1	1	-	1	1	1	-	1	1	1	-				●	●		●		●			●							●	●	Y	Y	X										
	TOTAL IMPROVEMENT							20.0																																														

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN.

Table 48. ALTERNATE PARTICULATE PLAN NO. 3

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS						% EMISSION REDUCTION	ug m^3 IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE												ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDER-ATIONS					LEGAL CONSID-ERATIONS		ENVIRON-MENTAL EFFECTS					PUBLIC RESPON-SIVENESS					REFER TO REMARKS SECTION
										DIRECT COSTS				ADMINIS-TRATIVE COSTS				SOCIAL COSTS				FLEXI-BILITY				APPLI-CATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	
INSTALL CONTROL DEVICES ON SMALL COMBUSTION UNITS	REGULATIONS, IMPROVE DESIGN SPECS.						●		10.0	1	2	1	-	1	1	1	-	1	1	1	-	●				●				●					●		●	●		●		Y	Y			-								
IMPROVE FURNACE DESIGN	IMPROVE SPECS.			●					0.5*	2	2	1	-	1	1	1	-	1	1	1	-	●				●		●			●				●		●				●	N	Y	x				x						
IMPROVE MAINTENANCE OF HEATING SYSTEM	REGULATORY CODE			●					1.1	1	2	1	-	1	1	1	-	1	1	1	-			●			●	●		●			●							●	●	Y	Y	x				x						
USE SMALLER AUTO ENGINE TO WEIGHT RATIO	TAX BY WEIGHT OR DISPLACEMENT		●						0.4	1	1	1	-	1	1	1	-	1	1		-			●		●		●		●				●				●				Y	N	x										
CONTROL CONSTRUCTION SITES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	1	1	-	1	1	1	-				●		●	●		●			●					●		●		Y	N	x										
CONTROL OF OPEN BODIED VEHICLES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	2	1	-	1	1	1	-	●				●			●	●			●							●		Y	Y	x										
	TOTAL IMPROVEMENT								19.0																																													

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN.

Table 49. THE TRIAL PARTICULATE PLAN

SOURCE CATEGORY		PERCENTAGE RANGE OF EFFECTIVENESS						%EMISSION REDUCTION	$\mu g/m^3$ IMPROVED AIR QUALITY	ECONOMIC IMPLICATIONS 1. NOT EXPENSIVE 2. MODERATELY EXPENSIVE 3. VERY EXPENSIVE											
										DIRECT COSTS				ADMINISTRATIVE COSTS				SOCIAL COSTS			
CONTROL MEASURES	POLICY INSTRUMENTS	0-2	2-5	5-10	10-25	25-50	50-100			TO POLLUTER	TO CONSUMER	TO GOVERNMENT	OTHER (IDENTIFY)	PROGRAM MANAGEMENT	ENFORCEMENT	MONITORING	OTHER (IDENTIFY)	AREA INCOME	AREA EMPLOYMENT	REGIONAL PRICES	OTHER (IDENTIFY)
CONTROL CONSTRUCTION SITES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	1	1	-	1	1	1	-
CONTROL OF OPEN BODIED VEHICLES	LOCAL ORDINANCES				●				3.5	2	1	1	-	1	2	1	-	1	1	1	-
CONTROL OF DEPOSITION ON ROADS	LOCAL ORDINANCES				●				1.5	2	1	1	-	1	2	1	-	1	1	1	-
MODIFY TIRE AND BRAKE WEAR DESIGN	DESIGN SPECS. FOR GREATER DURABILITY		●						0.7	2	2	1	-	1	1	1	-	1	1	1	-
IMPROVE MAINTENANCE OF HEATING SYSTEM	REGULATORY CODE			●					1.1	1	2	1	-	1	1	1	-	1	1	1	-
IMPROVE FURNACE DESIGN	IMPROVE DESIGN SPECS.			●					0.5	2	2	1	-	1	1	1	-	1	1	1	-
IMPROVE DOMESTIC & COMMERCIAL BUILDING INSULATION	BUILDING CODES			●					0.8	1	2	1	-	1	1	1	-	1	1	1	-
CONTROL ROOM TEMP. FOR A C & HEATING	ADVERTISING			●					0.8	1	2	1	-	1	1	1	-	1	1	1	-
EXCLUDE NEW SOURCES FROM SELECTED HOT SPOTS	REVISION OF GENERAL ZONING PLAN						●		2.2	2	1	2	-	2	1	1	-	2	2	2	-
CHANGE EXISTING LAND USES	URBAN RENEWAL, REVISION OF GENERAL AND ZONING PLAN						●		5.4	1	2	3	-	3	2	1	-	1	1	1	-
	TOTAL IMPROVEMENT								20.0												

SOURCE CATEGORY	ADMINISTRATIVE CONSIDERATIONS								TIMING CONSIDERATIONS							POLITICAL CONSIDERATIONS					LEGAL CONSIDERATIONS		ENVIRONMENTAL EFFECTS					PUBLIC RESPONSIVENESS					
	FLEXIBILITY				APPLICATION OF CONTROL				YEARS BEFORE IMPLEMENTATION			YEARS BEFORE EFFECTIVENESS REALIZED				LEVEL OF IMPLEMENTATION							INTERMEDIA										
CONTROL MEASURES	INFLEXIBLE	SOMEWHAT FLEXIBLE	MODERATELY FLEXIBLE	VERY FLEXIBLE	CONTINUOUS	NON-CONTINUOUS	SELECTIVE	UNIFORM	0-2	2-5	5-10	0-2	2-5	5-10	10+	FEDERAL	STATE	REGIONAL	LOCAL	PRIVATE	LEGAL PRECEDENT EXISTING	NEW LEGISLATION REQUIRED	OTHER GASES	WATER	SOLID WASTE	NOISE	ENERGY	1 LEAST ACCEPTABLE	2	3	4	5 MOST ACCEPTABLE	REFER TO REMARKS SECTION
CONTROL CONSTRUCTION SITES				●		●	●		●			●					●		●		Y	N	X										
CONTROL OF OPEN BODIED VEHICLES	●				●			●	●			●							●		Y	Y	X										
CONTROL OF DEPOSITION ON ROADS		●			●		●		●			●							●		Y	Y	X										
MODIFY TIRE AND BRAKE WEAR DESIGN		●			●				●				●			●				●	N	Y	X										
IMPROVE MAINTENANCE OF HEATING SYSTEM			●			●	●		●			●							●	●	Y	Y	X				X						
IMPROVE FURNACE DESIGN	●				●		●			●				●		●				●	N	Y	X				X						
IMPROVE DOMESTIC & COMMERCIAL BUILDING INSULATION	●				●		●		●					●					●		Y	Y	X			X	X						
CONTROL ROOM TEMP. FOR A C & HEATING				●		●	●		●			●				●	●	●	●	●	Y	N	X				X						
EXCLUDE NEW SOURCES FROM SELECTED HOT SPOTS			●							●				●					●		Y	N	X	X	X	X	X						
CHANGE EXISTING LAND USES			●				●			●				●		●			●		Y	N	X	X	X	X	X						
TOTAL IMPROVEMENT																																	

* NUMBER IS DIFFERENT FROM AMOUNT SHOWN ON TABLE OF MEASURES DUE TO THE SYNERGISTIC EFFECT OF OTHER MEASURES IN THIS PLAN.

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APPENDIX A

MOBILE SOURCE EMISSION FACTORS

The Mobile Source Emission Factors are determined by the equation

$$e_{np} = \Sigma c_{ip} \; d_{ipn} \; m_{in} \; s_p$$

where

e_n = emission factor in grams/mile for calendar year n and pollutant p

c_i = the 1975 Federal Test Procedure emission rate for pollutant p (grams/mile) for the i^{th} model year at low mileage

d_i = the controlled vehicle pollutant p emission deterioration factor for the i^{th} model year at calendar year n

m_i = the weighted annual travel of the i^{th} model year during the calendar year n.

s = the weighted speed adjustment factor for exhaust emission for the pollutant p (in the determination of the emission factors presented here the coefficient s was taken at 1.0, this is useful for average speeds equal to the average speed during the 1975 Federal Test Procedure or by the miltiplication of s_p for any speed road.)

In addition to exhaust emission factors, the calculation of hydrocarbon motor vehicle emission involves crankcase and evaporative hydrocarbon emission rates. Crankcase and evaporative emissions are determined by the equation

$$f_n = \Sigma \, h_i \; m_{in}$$

where

f_n = the combined crankcase and evaporative emission factor for year n

h_i = the combined crankcase and evaporative emission rate for the i^{th} model year

m_i = the weighted annual travel of the i^{th} model year during the calendar year n

The final HC emission factor (E_n) is the sum: $e_{nHC} + f_n$.

In order to make the emission factors city specific, vehicle age distribution was taken from Maryland state registration data for 1971 for light duty vehicles (See Table A-21). For heavy duty vehicles only national mileage data was available and thus it is not completely city specific. The weighted annual travel data (m) was taken from the "Technical Support Document for the Transportation Control Plan for the Metropolitan Baltimore Intrastate Region," Environmental Protection Agency, (March 1974).

For the other parameters, (c and d), the national figures were applicable and were used. The national figures and the above equations were taken from "An Interim Report on Motor Vehicle Emission Estimation" by D. S. Kircher and D. P. Armstrong, (October 1973).

The emission factors were calculated for the years 1972, 1975, 1977, 1980, and 1985 for the pollutants NO_X and HC. The results of these calculations are presented in Tables A-1 through A-20.

Table A-1. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☐ HDV ☒ LDV

Calendar year 1972 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)
19 72	4.8	1.00	0.097	1.0	0.466
19 71	4.8	1.00	0.225	1.0	1.080
19 70	5.1	1.00	0.145	1.0	0.740
19 69	5.5	1.00	0.115	1.0	0.633
19 68	4.3	1.00	0.089	1.0	0.383
19 67	3.6	1.00	0.086	1.0	0.310
19 66	3.6	1.00	0.077	1.0	0.277
19 65	3.6	1.00	0.061	1.0	0.220
19 64	3.6	1.00	0.045	1.0	0.162
19 63	3.6	1.00	0.028	1.0	0.101
19 62	3.6	1.00	0.013	1.0	0.047
19 61	3.6	1.00	0.007	1.0	0.025
19 60+ older	3.6	1.00	0.011	1.0	0.040

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 4.484$ g/mi

Table A-2. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☐ HDV ☒ LDV

Calendar year 1975 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)
1975	2.2	1.0	0.097	1.0	0.213
1974	2.3	1.11	0.225	1.0	0.574
1973	2.3	1.18	0.145	1.0	0.394
1972	4.8	1.0	0.115	1.0	0.552
1971	4.8	1.0	0.089	1.0	0.427
1970	5.1	1.0	0.086	1.0	0.439
1969	5.5	1.0	0.077	1.0	0.424
1968	4.3	1.0	0.061	1.0	0.262
1967	3.6	1.0	0.045	1.0	0.162
1966	3.6	1.0	0.028	1.0	0.101
1965	3.6	1.0	0.013	1.0	0.047
1964	3.6	1.0	0.007	1.0	0.025
1963+ older	3.6	1.0	0.011	1.0	0.040

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 3.664$ g/mi

Table A-3. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☐ HDV ☒ LDV

Calendar year 1977 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)
1977	0.31	1.0	0.097	1.0	0.030
1976	0.31	1.34	0.225	1.0	0.093
1975	2.2	1.18	0.145	1.0	0.376
1974	2.3	1.20	0.115	1.0	0.317
1973	2.3	1.21	0.089	1.0	0.248
1972	4.8	1.0	0.086	1.0	0.413
1971	4.8	1.0	0.077	1.0	0.370
1970	5.1	1.0	0.061	1.0	0.311
1969	5.5	1.0	0.045	1.0	0.248
1968	4.3	1.0	0.028	1.0	0.120
1967	3.6	1.0	0.013	1.0	0.047
1966	3.6	1.0	0.007	1.0	0.025
1965+ older	3.6	1.0	0.011	1.0	0.040

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 2.638$ g/mi

Table A-4. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☐ HDV ☒ LDV

Calendar year 1980 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)
1980	0.31	1.0	0.097	1.0	0.030
1979	0.31	1.34	0.225	1.0	0.093
1978	0.31	1.77	0.145	1.0	0.080
1977	0.31	2.14	0.115	1.0	0.076
1976	0.31	2.42	0.089	1.0	0.067
1975	2.2	1.41	0.086	1.0	0.267
1974	2.3	1.23	0.077	1.0	0.218
1973	2.3	1.24	0.061	1.0	0.174
1972	4.8	1.0	0.045	1.0	0.216
1971	4.8	1.0	0.028	1.0	0.134
1970	5.1	1.0	0.013	1.0	0.066
1969	5.5	1.0	0.007	1.0	0.039
1968+ older	3.6 (b)	1.0	0.011	1.0	0.040

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 1.5$ g/mi

(b) approximate

Table A-5. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x

Vehicle weight class

☐ HDV ☒ LDV

Calendar year 1985

Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$(a)
1985	0.31	1.0	0.097	1.0	0.030
1984	0.31	1.34	0.225	1.0	0.093
1983	0.31	1.77	0.145	1.0	0.080
1982	0.31	2.14	0.115	1.0	0.076
1981	0.31	2.42	0.089	1.0	0.067
1980	0.31	2.73	0.086	1.0	0.073
1979	0.31	2.99	0.077	1.0	0.071
1978	0.31	3.26	0.061	1.0	0.062
1977	0.31	3.48	0.045	1.0	0.049
1976	0.31	3.77	0.028	1.0	0.033
1975	2.2	1.45	0.013	1.0	0.041
1974	2.3	1.26	0.007	1.0	0.020
1973 + older	2.3(b)	1.26	0.011	1.0	0.032

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 0.727$ g/mi

(b) approximate

Table A-6. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS
1972 HYDROCARBONS FROM LIGHT DUTY VEHICLES

Model year	Exhaust emission factors					Crankcase and evaporative emission factors		
	c_i	d_i	m_i	s_i	$c_id_im_is_i$ (a)	h_i	m_i	h_im_i (b)
1972	2.7	1.0	0.097	1.0	0.262	0.2	0.097	0.019
1971	2.9	1.05	0.225	1.0	0.685	0.5	0.225	0.113
1970	3.6	1.10	0.145	1.0	0.574	3.0	0.145	0.435
1969	4.4	1.18	0.115	1.0	0.597	3.0	0.115	0.345
1968	4.5	1.23	0.089	1.0	0.493	3.0	0.089	0.267
1967	8.8	1.0	0.086	1.0	0.757	3.8	0.086	0.327
1966	8.8	1.0	0.077	1.0	0.678	3.8	0.077	0.293
1965	8.8	1.0	0.061	1.0	0.537	3.8	0.061	0.232
1964	8.8	1.0	0.045	1.0	0.396	3.8	0.045	0.171
1963	8.8	1.0	0.028	1.0	0.246	3.8	0.028	0.106
1962	8.8	1.0	0.013	1.0	0.114	7.1	0.013	0.092
1961	8.8	1.0	0.007	1.0	0.062	7.1	0.007	0.050
1960+ older	8.8	1.0	0.011	1.0	0.097	7.1(c)	0.011	0.078

(a) $\sum c_id_im_is_i$ = 5.498 g/mi

(b) $\sum h_im_i$ = 2.528 g/mi

(c) Total emission (E_n) = 5.498 plus 2.528 = 8.026 g/mi

Table A-7. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS 1975 HYDROCARBONS FROM LIGHT DUTY VEHICLES

	Exhaust emission factors					Crankcase and evaporative emission factors		
Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1975	1.3	1.0	0.097	1.0	0.126	0.2	0.097	0.019
1974	2.7	1.05	0.225	1.0	0.638	0.2	0.225	0.045
1973	2.7	1.10	0.145	1.0	0.431	0.2	0.145	0.029
1972	2.7	1.13	0.115	1.0	0.351	0.2	0.115	0.023
1971	2.9	1.15	0.089	1.0	0.299	0.5	0.089	0.045
1970	3.6	1.17	0.086	1.0	0.362	3.0	0.086	0.258
1969	4.4	1.25	0.077	1.0	0.424	3.0	0.077	0.231
1968	4.5	1.30	0.061	1.0	0.357	3.0	0.061	0.183
1967	8.8	1.0	0.045	1.0	0.396	3.8	0.045	0.171
1966	8.8	1.0	0.028	1.0	0.246	3.8	0.028	0.106
1965	8.8	1.0	0.013	1.0	0.114	3.8	0.013	0.049
1964	8.8	1.0	0.007	1.0	0.062	3.8	0.007	0.027
1963+ older	8.8	1.0	0.011	1.0	0.097	5.5 (c)	0.011	0.061

(a) $\sum c_i d_i m_i s_i = 3.903$ g/mi

(b) $\sum h_i m_i = 1.247$g/mi

(c) Total emission (E_n) = 3.903 plus 1.247 = 5.150 g/mi

Table A-8. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS 1977 HYDROCARBONS FROM LIGHT DUTY VEHICLES

Model year	Exhaust emission factors					Crankcase and evaporative emission factors		
	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1977	.23	1.0	0.097	1.0	0.022	0.2	0.097	0.019
1976	.23	1.45	0.225	1.0	0.075	0.2	0.225	0.045
1975	1.3	1.13	0.145	1.0	0.213	0.2	0.145	0.029
1974	2.7	1.13	0.115	1.0	0.351	0.2	0.115	0.023
1973	2.7	1.15	0.089	1.0	0.276	0.2	0.089	0.018
1972	2.7	1.17	0.086	1.0	0.272	0.2	0.086	0.017
1971	2.9	1.20	0.077	1.0	0.268	0.5	0.077	0.039
1970	3.6	1.22	0.061	1.0	0.268	3.0	0.061	0.183
1969	4.4	1.29	0.045	1.0	0.255	3.0	0.045	0.135
1968	4.5	1.35	0.028	1.0	0.170	3.0	0.028	0.084
1967	8.8	1.00	0.013	1.0	0.114	3.8	0.013	0.049
1966	8.8	1.00	0.007	1.0	0.062	3.8	0.007	0.027
1965+ older	8.8	1.00	0.011	1.0	0.097	3.8(c)	0.011	0.042

(a) $\sum c_i d_i m_i s_i$ = 2.443 g/mi

(b) $h_i m_i$ = .71 g/mi

(c) Total emission (E_n) = 2.443 plus .71 = 2.5114 g/mi

Table A-9. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS
1980 HYDROCARBONS FROM LIGHT DUTY VEHICLES

Model year	Exhaust emission factors					Crankcase and evaporative emission factors		
	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1980	.23	1.0	0.097	1.0	0.022	0.2	0.097	0.019
1979	.23	1.45	0.225	1.0	0.075	0.2	0.225	0.045
1978	.23	1.95	0.145	1.0	0.065	0.2	0.145	0.029
1977	.23	2.40	0.115	1.0	0.063	0.2	0.115	0.023
1976	.23	2.76	0.089	1.0	0.056	0.2	0.089	0.018
1975	1.3	1.37	0.086	1.0	0.153	0.2	0.086	0.017
1974	2.7	1.20	0.077	1.0	0.249	0.2	0.077	0.015
1973	2.7	1.22	0.061	1.0	0.201	0.2	0.061	0.012
1972	2.7	1.24	0.045	1.0	0.151	0.2	0.045	0.009
1971	2.9	1.26	0.028	1.0	0.102	0.5	0.028	0.014
1970	3.6	1.26	0.013	1.0	0.059	3.0	0.013	0.039
1969	4.4	1.31	0.007	1.0	0.040	3.0	0.007	0.021
1968+ older	8.0*	1.0	0.011	1.0	0.088	3.4 (c)	0.011	0.037

(a) $\sum c_i d_i m_i s_i$ = 1.324 g/mi

(b) $\sum h_i m_i$ =.298 g/mi

(c) Total emission (E_n) = 1.324 plus .298 = 1.622 g/mi

Table A-10. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS 1985 HYDROCARBONS FROM LIGHT DUTY VEHICLES

Model year	Exhaust emission factors					Crankcase and evaporative emission factors		
	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1985	.23	1.0	0.097	1.0	0.022	0.2	0.097	0.019
1984	.23	1.45	0.225	1.0	0.075	0.2	0.225	0.045
1983	.23	1.95	0.145	1.0	0.065	0.2	0.145	0.029
1982	.23	2.4	0.115	1.0	0.063	0.2	0.115	0.023
1981	.23	2.76	0.089	1.0	0.056	0.2	0.089	0.018
1980	.23	3.14	0.086	1.0	0.062	0.2	0.086	0.017
1979	.23	3.46	0.077	1.0	0.061	0.2	0.077	0.015
1978	.23	3.79	0.061	1.0	0.053	0.2	0.061	0.012
1977	.23	4.07	0.045	1.0	0.042	0.2	0.045	0.009
1976	.23	4.42	0.028	1.0	0.028	0.2	0.028	0.006
1975	1.3	1.63	0.013	1.0	0.028	0.2	0.013	0.003
1974	2.7	1.26	0.007	1.0	0.024	0.2	0.007	0.001
1973+ older	2.7	1.26	0.011	1.0	0.037	0.2 (c)	0.011	0.002

(a) $\sum c_i d_i m_i s_i = .616$ g/mi

(b) $\sum h_i m_i = .199$ g/mi

(c) Total emission (E_n) = .616 plus .199 = 0.815 g/mi

Table A-11. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x ________ Vehicle weight class

☒ HDV ☐ LDV

Calendar year 1972 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_id_im_is_i$ (a)
1972	9.2	1.0	.080	1.0	.736
1971	9.2	1.0	.143	1.0	1.316
1970	9.2	1.0	.174	1.0	1.601
1969	9.4	1.0	.113	1.0	1.062
1968	9.4	1.0	.109	1.0	1.025
1967	9.4	1.0	.091	1.0	.855
1966	9.4	1.0	.074	1.0	.696
1965	9.4	1.0	.055	1.0	.517
1964	9.4	1.0	.042	1.0	.395
1963	9.4	1.0	.027	1.0	.254
1962	9.4	1.0	.020	1.0	.188
1961	9.4	1.0	.011	1.0	.103
1960 +older	9.4	1.0	.061	1.0	.573

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 9.321$ g/mi

Table A-12. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☒ HDV ☐ LDV

Calendar year 1975 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$(a)
1975	9.2	1.0	.080	1.0	.736
1974	9.2	1.0	.143	1.0	1.316
1973	9.2	1.0	.174	1.0	1.601
1972	9.2	1.0	.113	1.0	1.040
1971	9.2	1.0	.109	1.0	1.003
1970	9.2	1.0	.091	1.0	.837
1969	9.4	1.0	.074	1.0	.696
1968	9.4	1.0	.055	1.0	.517
1967	9.4	1.0	.042	1.0	.395
1966	9.4	1.0	.027	1.0	.254
1965	9.4	1.0	.020	1.0	.188
1964	9.4	1.0	.011	1.0	.103
1963 +older	9.4	1.0	.061	1.0	.573

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 9.259$ g/mi

Table A-13. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☒ HDV ☐ LDV

Calendar year 1977 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_id_im_is_i$ (a)
1977	9.2	1.0	.080	1.0	.736
1976	9.2	1.0	.143	1.0	1.316
1975	9.2	1.0	.174	1.0	1.601
1974	9.2	1.0	.113	1.0	1.040
1973	9.2	1.0	.109	1.0	1.003
1972	9.2	1.0	.091	1.0	.837
1971	9.2	1.0	.074	1.0	.681
1970	9.2	1.0	.055	1.0	.506
1969	9.4	1.0	.042	1.0	.395
1968	9.4	1.0	.027	1.0	.254
1967	9.4	1.0	.020	1.0	.188
1966	9.4	1.0	.011	1.0	.103
1965 +older	9.4	1.0	.061	1.0	.573

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 9.230$ g/mi

Table A-14. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☒ HDV ☐ LDV

Calendar year 1980 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)
1980	9.2	1.0	.080	1.0	.736
1979	9.2	1.0	.143	1.0	1.316
1978	9.2	1.0	.174	1.0	1.601
1977	9.2	1.0	.113	1.0	1.040
1976	9.2	1.0	.109	1.0	1.003
1975	9.2	1.0	.091	1.0	.837
1974	9.2	1.0	.074	1.0	.681
1973	9.2	1.0	.055	1.0	.506
1972	9.2	1.0	.042	1.0	.386
1971	9.2	1.0	.027	1.0	.248
1970	9.2	1.0	.020	1.0	.184
1969	9.4	1.0	.011	1.0	.103
1968 +older	9.4	1.0	.061	1.0	.573

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 9.214$ g/mi

Table A-15. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EXHAUST EMISSION FACTORS

Pollutant NO_x Vehicle weight class

☒ HDV ☐ LDV

Calendar year 1985 Metropolitan area Balt.

Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$(a)
1985	9.2	1.0	.080	1.0	.736
1984	9.2	1.0	.143	1.0	1.316
1983	9.2	1.0	.174	1.0	1.601
1982	9.2	1.0	.113	1.0	1.040
1981	9.2	1.0	.109	1.0	1.003
1980	9.2	1.0	.091	1.0	.837
1979	9.2	1.0	.074	1.0	.681
1978	9.2	1.0	.055	1.0	.506
1977	9.2	1.0	.042	1.0	.386
1976	9.2	1.0	.027	1.0	.248
1975	9.2	1.0	.020	1.0	.184
1974	9.2	1.0	.011	1.0	.101
1973	9.2	1.0	.061	1.0	.561

(a) Final $E_{NO_x} = \sum c_i d_i m_i s_i = 9.200$ g/mi

Table A-16. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS 1972 HYDROCARBONS FROM HEAVY DUTY VEHICLES

	Exhaust emission factors					Crankcase and evaporative emission factors		
Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$(a)	h_i	m_i	$h_i m_i$(b)
1972	16	1.0	0.080	1.0	1.28	3.0	0.080	0.240
1971	16	1.0	0.143	1.0	2.288	3.0	0.143	0.429
1970	16	1.0	0.174	1.0	2.784	8.2	0.174	1.427
1969	17	1.0	0.113	1.0	1.921	8.2	0.113	0.927
1968	17	1.0	0.109	1.0	1.853	8.2	0.109	0.894
1967	17	1.0	0.091	1.0	1.547	8.2	0.091	0.746
1966	17	1.0	0.074	1.0	1.258	8.2	0.074	0.607
1965	17	1.0	0.055	1.0	0.935	8.2	0.055	0.451
1964	17	1.0	0.042	1.0	0.714	8.2	0.042	0.344
1963	17	1.0	0.027	1.0	0.459	8.2	0.027	0.221
1962	17	1.0	0.020	1.0	0.340	8.2	0.020	0.164
1961	17	1.0	0.011	1.0	0.187	8.2	0.011	0.090
1960 +older	17	1.0	0.061	1.0	1.037	8.2(c)	0.061	0.500

(a) $\sum c_i d_i m_i s_i = 16.603$ g/mi

(b) $\sum h_i m_i = 7.040$ g/mi

(c) Total emission (E_n) = 16.603 plus 7.040 = 23.643 g/mi

Table A-17. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS
1975 HYDROCARBONS FROM HEAVY DUTY VEHICLES

	Exhaust emission factors					Crankcase and evaporative emission factors		
Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1975	13	1.0	0.080	1.0	1.040	3.0	0.080	0.240
1974	13	1.0	0.143	1.0	1.859	3.0	0.143	0.429
1973	16	1.0	0.174	1.0	2.784	3.0	0.174	0.522
1972	16	1.0	0.113	1.0	1.808	3.0	0.113	0.339
1971	16	1.0	0.109	1.0	1.744	3.0	0.109	0.327
1970	16	1.0	0.091	1.0	1.456	8.2	0.091	0.746
1969	17	1.0	0.074	1.0	1.258	8.2	0.074	0.607
1968	17	1.0	0.055	1.0	0.935	8.2	0.055	0.451
1967	17	1.0	0.042	1.0	0.714	8.2	0.042	0.344
1966	17	1.0	0.027	1.0	0.459	8.2	0.027	0.221
1965	17	1.0	0.020	1.0	0.340	8.2	0.020	0.164
1964	17	1.0	0.011	1.0	0.187	8.2	0.011	0.090
1963 +older	17	1.0	0.061	1.0	1.037	8.2 (c)	0.061	0.500

(a) $\sum c_i d_i m_i s_i = 15.621$ g/mi

(b) $\sum h_i m_i = 4.980$ g/mi

(c) Total emission (F_n) = 15.621 plus 4.980 = 20.601 g/mi

Table A-18. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS
1977 HYDROCARBONS FROM HEAVY DUTY VEHICLES

	Exhaust emission factors					Crankcase and evaporative emission factors		
Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1977	13	1.0	0.080	1.0	1.040	3.0	0.080	0.240
1976	13	1.0	0.143	1.0	1.859	3.0	0.143	0.429
1975	13	1.0	0.174	1.0	2.262	3.0	0.174	0.522
1974	13	1.0	0.113	1.0	1.469	3.0	0.113	0.339
1973	16	1.0	0.109	1.0	1.744	3.0	0.109	0.327
1972	16	1.0	0.091	1.0	1.456	3.0	0.091	0.273
1971	16	1.0	0.074	1.0	1.184	3.0	0.074	0.222
1970	16	1.0	0.055	1.0	0.880	8.2	0.055	0.451
1960	17	1.0	0.042	1.0	0.714	8.2	0.042	0.344
1968	17	1.0	0.027	1.0	0.459	8.2	0.027	0.221
1967	17	1.0	0.020	1.0	0.340	8.2	0.020	0.164
1966	17	1.0	0.011	1.0	0.187	8.2	0.011	0.090
1965 +older	17	1.0	0.061	1.0	1.037	8.2 (c)	0.061	0.500

(a) $\sum c_i d_i m_i s_i = 14.631$ g/mi

(b) $\sum h_i m_i = 4.122$ g/mi

(c) Total emission (E_n) = 14.631 plus 4.122 = 18.753 g/mi

Table A-19. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS 1980 HYDROCARBONS FROM HEAVY DUTY VEHICLES

	Exhaust emission factors					Crankcase and evaporative emission factors		
Model year	c_i	d_i	m_i	s_i	$c_i d_i m_i s_i$ (a)	h_i	m_i	$h_i m_i$ (b)
1980	13	1.0	0.080	1.0	1.040	3.0	0.080	0.240
1979	13	1.0	0.143	1.0	1.859	3.0	0.143	0.429
1978	13	1.0	0.174	1.0	2.262	3.0	0.174	0.522
1977	13	1.0	0.113	1.0	1.469	3.0	0.113	0.339
1976	13	1.0	0.109	1.0	1.417	3.0	0.109	0.327
1975	13	1.0	0.091	1.0	1.183	3.0	0.091	0.273
1974	13	1.0	0.074	1.0	0.962	3.0	0.074	0.222
1973	16	1.0	0.055	1.0	0.880	3.0	0.055	0.165
1972	16	1.0	0.042	1.0	0.672	3.0	0.042	0.126
1971	16	1.0	0.027	1.0	0.432	3.0	0.027	0.081
1970	16	1.0	0.020	1.0	0.320	8.2	0.020	0.164
1969	17	1.0	0.011	1.0	0.187	8.2	0.011	0.090
1968 +older	17	1.0	0.061	1.0	1.037	8.2 (c)	0.061	0.500

(a) $\sum c_i d_i m_i s_i = 13.720$ g/mi
(b) $\sum h_i m_i = 3.478$ g/mi

(c) Total emission (E_n) = 13.720 plus 3.478 = 17.198 g/mi

Table A-20. CALCULATION SHEET FOR GASOLINE MOTOR VEHICLE EMISSION FACTORS
1985 HYDROCARBONS FROM HEAVY DUTY VEHICLES

	Exhaust emission factors					Crankcase and evaporative emission factors		
Model year	c_i	d_i	m_i	s_i	$c_id_im_is_i$ (a)	h_i	m_i	h_im_i (b)
1985	13	1.0	0.080	1.0	1.040	3.0	0.080	0.240
1984	13	1.0	0.143	1.0	1.859	3.0	0.143	0.429
1983	13	1.0	0.174	1.0	2.262	3.0	0.174	0.522
1982	13	1.0	0.113	1.0	1.469	3.0	0.113	0.339
1981	13	1.0	0.109	1.0	1.417	3.0	0.109	0.327
1980	13	1.0	0.091	1.0	1.183	3.0	0.091	0.273
1979	13	1.0	0.074	1.0	0.962	3.0	0.074	0.222
1978	13	1.0	0.055	1.0	0.715	3.0	0.055	0.165
1977	13	1.0	0.042	1.0	0.546	3.0	0.042	0.126
1976	13	1.0	0.027	1.0	0.351	3.0	0.027	0.081
1975	13	1.0	0.020	1.0	0.260	3.0	0.020	0.060
1974	13	1.0	0.011	1.0	0.143	3.0	0.011	0.033
1973 +older	16	1.0	0.061	1.0	0.976	3.0 (c)	0.061	0.183

(a) $\sum c_id_im_is_i = 13.183$ g/mi

(b) $\sum h_im_i = 3.000$ g/mi

(c) Total emission (E_n) = 13.183 plus 3.000 = 16.183 g/mi

Table A-21 WEIGHTED ANNUAL MILES TO TRAVEL

Vehicle Age	Light Duty Vehicles				Heavy Duty Vehicles			
	Vehicle Age Dist. % (a)	Miles Driven (b)	(a)×(b)	$M = \frac{a \times b}{\Sigma(a \times b)}$	Vehicle Age Dist. % (a)	Miles Driven (b)	(a)×(b)	$M = \frac{a \times b}{\Sigma(a \times b)}$
1	9.7	9,900*	960.3	0.097	9.1	10,500**	955.5	0.080
2	17.3	12,900	2231.7	0.225	14.5	11,700	1696.5	0.143
3	12.3	11,750	1445.3	0.145	12.0	17,200	2064.0	0.174
4	10.7	10,650	1139.6	0.115	8.5	15,800	1343.0	0.113
5	9.3	9,550	888.2	0.089	8.2	15,800	1295.6	0.109
6	9.3	9,225	857.9	0.086	8.3	13,000	1079.0	0.091
7	8.8	8,675	763.4	0.077	6.8	13,000	884.0	0.074
8	7.2	8,475	610.2	0.061	5.9	11,000	649.0	0.055
9	5.6	7,900	442.4	0.045	4.5	11,000	495.0	0.042
10	3.9	7,225	281.8	0.028	3.6	9,000	324.0	0.027
11	2.0	6,675	133.5	0.013	2.6	9,000	234.0	0.020
12	1.4	5,200	72.8	0.007	2.4	5,500	132.0	0.011
13+	2.5	4,500	112.5	0.011	13.1	5,550	720.5	0.061
Totals			9939.6	0.999			11872.1	1.000

* Maryland State Data, 1st year cars driven only 3/4 x 13,200 = 9,900 miles by May 31.

** Since 3,500 for 1st year covers 1/4 of year, 3/4 of year = 3 x 3,500 = 10,500 miles by May 31.

APPENDIX B

TRANSPORTATION DATA

Table B-1 lists current and projected light duty vehicles (LDV) and heavy and medium duty vehicles (HMDV) miles traveled and average speed by regional planning district. VMT are listed in thousands of miles during the peak period 6 to 9 A.M. Speed is in miles per hour. Details of the derivation of the data are given in the basic report.

Data were available for only those planning districts included in the 1964 Baltimore Metropolitan Area Transportation Study. Figure B-1 shows the study area within the AQCR.

Table B-1. VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
101	LDV(a)	11.97	13.59	14.28	13.72
	HMDV(b)	2.36	2.68	2.82	2.71
	SPEED(c)	16.90	16.20	15.90	16.00
102	LDV	32.11	32.73	35.85	38.26
	HMDV	6.34	6.85	7.08	7.55
	SPEED	30.80	29.70	29.20	28.10
103	LDV	36.32	40.34	42.06	42.50
	HMDV	7.15	7.96	8.30	8.39
	SPEED	18.60	14.90	13.30	13.20
104	LDV	11.77	12.24	12.44	12.91
	HMDV	2.31	2.41	2.46	2.55
	SPEED	16.20	15.70	15.50	16.60
105	LDV	34.09	34.64	34.87	35.08
	HMDV	6.72	6.84	6.88	6.92
	SPEED	15.00	14.50	14.30	14.60
106	LDV	44.11	44.43	44.57	44.79
	HMDV	8.70	8.77	8.80	8.84
	SPEED	14.90	15.00	15.10	16.40
107	LDV	36.90	46.17	50.13	50.39
	HMDV	7.28	9.11	9.89	9.94
	SPEED	14.20	15.50	16.10	16.30
108	LDV	17.87	21.24	22.68	21.79
	HMDV	3.52	4.19	4.48	4.30
	SPEED	16.90	14.00	12.80	13.30
109	LDV	22.74	24.72	25.57	25.80
	HMDV	4.49	4.88	5.05	5.09
	SPEED	13.70	12.50	12.00	12.70
110	LDV	23.88	27.29	28.76	29.30
	HMDV	4.72	5.38	5.68	5.78
	SPEED	36.50	31.30	29.10	28.60

Table B-1 (continued). VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
111	LDV(a)	45.18	48.57	50.02	49.73
	HMDV(b)	8.91	9.58	9.88	9.82
	SPEED(c)	24.00	22.60	22.00	22.40
112	LDV	21.40	19.50	18.69	19.70
	HMDV	4.22	3.85	3.69	3.89
	SPEED	12.00	13.60	14.30	14.30
113	LDV	40.15	43.16	44.45	44.28
	HMDV	7.92	8.52	8.78	8.74
	SPEED	27.90	28.80	29.20	28.90
114	LDV	7.63	6.50	6.02	6.48
	HMDV	1.51	1.28	1.19	1.28
	SPEED	19.30	22.70	24.20	23.00
115	LDV	21.04	30.21	34.13	36.67
	HMDV	4.15	5.96	6.74	7.24
	SPEED	10.60	27.70	35.10	32.70
116	LDV	22.85	35.45	40.85	42.92
	HMDV	4.51	7.00	8.06	8.47
	SPEED	15.70	30.30	36.60	36.40
117	LDV	59.36	64.71	67.01	67.57
	HMDV	11.71	12.77	13.22	13.33
	SPEED	18.30	23.10	25.10	25.00
118	LDV	54.97	67.34	72.63	73.43
	HMDV	10.85	13.29	14.33	14.49
	SPEED	14.60	19.80	22.00	20.80
119	LDV	64.91	60.77	59.00	59.17
	HMDV	12.82	12.00	11.65	11.68
	SPEED	19.70	23.90	25.70	25.30
120	LDV	29.31	35.06	37.52	36.31
	HMDV	5.79	6.92	7.40	7.16
	SPEED	11.90	31.20	39.40	45.70

Table B-1 (continued). VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
121	LDV(a)	95.76	124.31	136.55	138.01
	HMDV(b)	18.89	24.54	26.95	27.21
	SPEED(c)	24.50	36.80	42.00	43.00
122	LDV	17.63	37.02	45.33	47.61
	HMDV	3.44	7.31	8.94	9.40
	SPEED	17.70	26.00	29.60	28.90
123	LDV	23.88	41.53	49.10	51.53
	HMDV	4.72	8.20	9.69	10.18
	SPEED	14.80	30.60	37.40	36.60
124	LDV	13.73	27.87	33.93	34.55
	HMDV	2.71	5.50	6.69	6.82
	SPEED	22.40	37.20	43.60	44.20
125	LDV	32.96	34.71	35.46	37.51
	HMDV	6.50	6.85	7.00	7.40
	SPEED	30.40	27.90	26.90	25.80
126	LDV	48.96	59.84	64.51	67.92
	HMDV	9.66	11.81	12.73	13.41
	SPEED	25.20	28.70	30.20	31.40
201	LDV	109.99	127.00	134.42	143.40
	HMDV	21.71	25.08	26.53	28.31
	SPEED	17.50	25.30	28.70	30.50
202	LDV	47.30	69.96	79.67	86.68
	HMDV	9.34	13.81	15.73	17.11
	SPEED	35.70	35.80	35.90	38.30
203	LDV	64.94	94.18	106.72	122.88
	HMDV	12.82	18.59	21.06	22.28
	SPEED	24.50	31.20	34.10	33.50
204	LDV	9.89	19.83	24.09	23.98
	HMDV	1.95	3.92	4.75	4.73
	SPEED	17.10	21.40	23.20	22.20

Table B-1 (continued). VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
205	LDV[a]	83.23	85.89	87.03	116.59
	HMDV[b]	16.43	16.95	17.18	23.01
	SPEED[c]	20.10	19.30	19.00	20.30
206	LDV	60.97	89.16	101.24	119.93
	HMDV	12.03	17.60	19.99	23.67
	SPEED	26.00	32.40	35.20	32.90
207	LDV	10.73	14.95	16.75	18.16
	HMDV	2.12	2.95	3.31	3.59
	SPEED	18.00	13.30	11.30	12.90
208	LDV	32.94	44.55	49.52	52.20
	HMDV	6.50	8.80	9.78	10.31
	SPEED	23.70	20.30	18.80	22.50
209	LDV	29.75	33.16	34.62	38.87
	HMDV	5.87	6.54	6.84	7.67
	SPEED	20.00	19.20	18.80	25.40
210	LDV	35.05	40.89	43.40	68.93
	HMDV	6.92	8.07	8.56	13.61
	SPEED	11.40	10.00	9.40	18.90
303	LDV	8.85	15.59	18.48	20.14
	HMDV	1.75	3.08	3.65	3.98
	SPEED	28.00	25.10	23.90	24.30
304	LDV	12.85	17.90	20.06	21.72
	HMDV	2.54	3.53	3.96	4.29
	SPEED	44.50	42.10	41.10	41.30
305	LDV	8.61	10.72	11.62	11.97
	HMDV	1.71	2.72	2.29	2.36
	SPEED	19.80	18.30	17.70	18.10
306	LDV	19.34	41.66	51.23	55.55
	HMDV	3.82	8.22	10.13	10.97
	SPEED	16.00	30.10	36.10	35.00

Table B-1 (continued). VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
307	LDV(a)	19.61	25.56	28.11	37.55
	HDV(b)	3.87	5.04	5.53	7.41
	SPEED(c)	37.00	38.20	38.70	36.50
308	LDV	48.04	63.16	69.63	70.71
	HDV	9.48	12.47	13.79	13.95
	SPEED	37.10	36.10	35.70	35.70
309	LDV	13.33	18.65	20.93	21.25
	HDV	2.63	3.68	4.13	4.20
	SPEED	18.80	18.40	18.30	19.20
310	LDV	4.27	5.89	6.58	7.46
	HDV	0.85	1.16	1.27	1.47
	SPEED	18.00	17.40	17.10	20.80
311	LDV	8.33	11.83	13.33	31.89
	HDV	1.65	2.33	2.60	6.29
	SPEED	19.60	15.40	13.60	20.90
312	LDV	9.53	12.90	14.35	19.13
	HDV	1.88	2.55	2.80	3.78
	SPEED	17.20	16.70	16.50	19.70
313	LDV	96.97	116.94	125.50	138.58
	HDV	19.14	23.08	24.72	27.36
	SPEED	35.80	33.30	32.20	32.00
314	LDV	25.00	28.42	29.88	32.62
	HDV	4.93	5.60	5.86	6.44
	SPEED	35.70	32.70	31.40	31.30
315	LDV	75.82	89.74	95.71	101.61
	HDV	14.97	17.71	18.86	20.06
	SPEED	36.60	33.90	32.80	34.10
316	LDV	43.08	65.56	75.20	74.23
	HDV	8.50	12.94	14.86	14.65
	SPEED	33.00	28.11	26.00	27.90

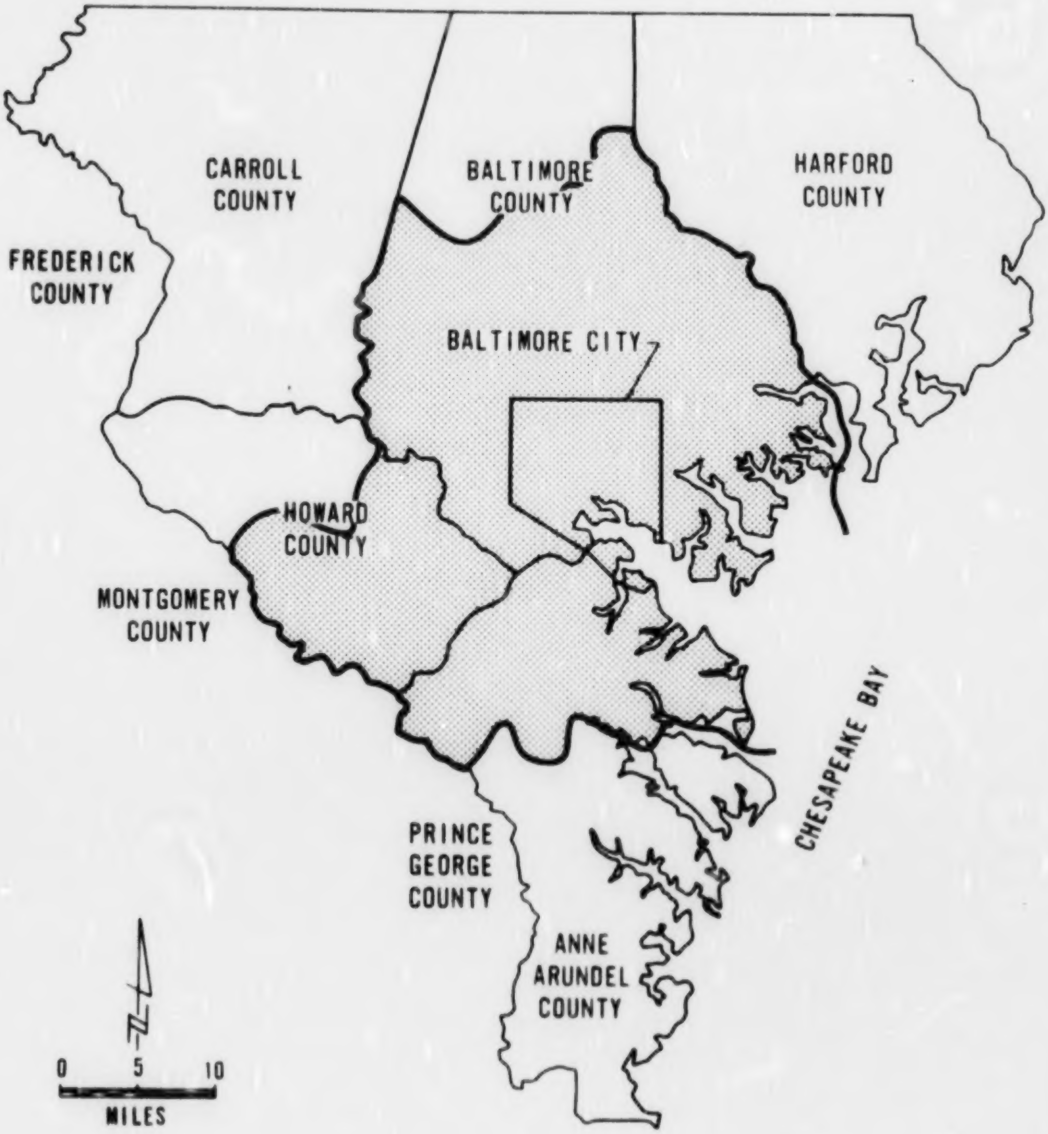
Table B-1 (continued). VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
317	LDV(a)	40.24	57.80	65.33	71.57
	HMDV(b)	7.94	11.41	12.86	14.13
	SPEED(c)	38.70	33.00	30.60	34.10
318	LDV	22.58	28.92	31.65	34.99
	HMDV	4.46	5.71	6.20	6.91
	SPEED	29.2	24.40	22.40	27.20
319	LDV	74.53	100.46	111.58	121.51
	HMDV	14.71	19.83	21.99	23.98
	SPEED	29.40	23.80	21.40	22.80
320	LDV	26.72	29.35	30.47	37.56
	HMDV	5.27	5.79	6.00	7.41
	SPEED	47.60	37.50	33.20	33.90
321	LDV	22.48	28.43	30.97	33.39
	HMDV	4.43	5.61	6.13	6.59
	SPEED	49.80	40.60	36.00	40.30
322	LDV	4.51	6.55	7.43	11.28
	HMDV	0.89	1.29	1.47	2.23
	SPEED	26.70	22.60	20.80	27.80
323	LDV	68.83	107.68	124.32	134.66
	HMDV	13.59	21.25	24.52	26.58
	SPEED	41.50	37.60	36.00	34.80
324	LDV	50.81	64.04	69.71	74.88
	HMDV	10.04	12.64	13.79	14.78
	SPEED	34.10	27.70	25.00	24.40
325	LDV	80.08	133.85	156.90	167.20
	HMDV	15.81	26.42	30.92	33.00
	SPEED	33.30	33.90	34.10	33.70
326	LDV	31.61	56.33	66.93	74.69
	HMDV	6.24	11.12	13.19	14.74
	SPEED	35.20	33.40	32.70	32.90

Table B-1 (continued). VEHICLE MILES TRAVELED AND AVERAGE SPEED BY PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD		1970	1977	1980	1985
327	LDV(a)	19.34	22.93	24.48	24.22
	HMDV(b)	3.81	4.52	4.80	4.78
	SPEED(c)	13.90	13.10	12.70	19.50
328	LDV	26.79	32.43	34.86	37.23
	HMDV	5.28	6.40	6.87	7.36
	SPEED	13.60	17.10	19.00	21.60
329	LDV	50.51	52.90	53.93	53.38
	HMDV	9.98	10.44	10.66	10.53
	SPEED	13.40	21.20	24.50	25.60
330	LDV	27.45	37.84	42.28	42.17
	HMDV	5.42	7.47	8.39	8.32
	SPEED	11.60	25.20	31.00	31.90
331	LDV	13.37	15.71	16.71	19.23
	HMDV	2.65	3.10	3.33	3.80
	SPEED	13.50	22.30	26.10	27.60
603	LDV	51.71	76.84	87.61	107.93
	HMDV	10.20	15.17	17.33	21.30
	SPEED	39.50	37.50	36.70	35.10
604	LDV	11.16	14.28	15.61	17.34
	HMDV	2.21	2.82	3.13	3.42
	SPEED	26.40	27.40	27.90	29.20
605	LDV	24.99	81.11	105.16	117.94
	HMDV	4.93	16.01	20.73	23.28
	SPEED	16.30	23.80	27.00	32.60
606	LDV	24.40	65.46	108.20	122.68
	HMDV	4.82	12.92	21.32	24.22
	SPEED	10.20	22.10	27.20	28.30
607	LDV	38.50	62.95	73.43	85.81
	HMDV	7.60	12.42	14.53	16.94
	SPEED	9.80	17.40	20.60	24.40

(a) LDV: Light Duty Vehicles
(b) HMDV: Heavy and medium Duty Vehicles
(c) SPEED: in miles per hour


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
HOWARD COUNTY
MONTGOMERY COUNTY
CHESAPEAKE BAY
PRINCE GEORGE COUNTY
ANNE ARUNDEL COUNTY
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MILES

Figure B-1. BMATS study area

APPENDIX C

AUTOMOTIVE HYDROCARBON EMISSIONS

Tables C-1 through C-6 are the calculation sheets for determining total emissions during the peak period (6:00 to 9:00 a.m.) for the two categories of automotive sources for each of the years 1977, 1980, and 1985 for Light Duty Vehicles and for Heavy Duty Vehicles.

Exhaust and evaporative emission factors are taken from Appendix A. Speed factors are taken from "An Interim Report on Motor Vehicle Emission Estimation" by D. S. Kircher and D. P. Armstrong, EPA, October 1973.

VMT shown are the total by speed class summed from Appendix B. The grand total peak hour emissions are the sum of the exhaust emissions, dependent upon speed and the evaporative emissions, independent of speed.

Table C-1. AUTOMOTIVE HYDROCARBON EMISSIONS - 1977 LDV

Speed	VMT x 10^{-3}	Exhaust factor	Speed factor	Exhaust emission
10.45	40.89	2.443	1.36	135.86
12.45	24.72		1.29	77.90
13.45	57.83		1.25	175.22
14.45	96.22		1.21	284.43
15.45	114.67		1.17	327.76
16.45	26.49		1.13	73.13
17.45	101.27		1.10	272.14
18.45	29.37		1.06	76.06
19.45	186.39		1.02	464.46
20.45	44.55		0.99	107.75
21.45	72.73		0.96	170.57
22.45	142.79		0.93	324.42
23.45	307.05		0.90	675.11
24.45	28.92		0.87	61.47
25.45	180.52		0.84	370.45
26.45	37.02		0.83	75.07
27.45	143.24		0.81	283.45
28.45	168.56		0.79	325.32
29.45	34.73		0.78	66.18
30.45	118.64		0.76	220.28
31.45	156.53		0.75	286.80
32.45	117.58		0.73	209.69
33.45	454.66		0.72	799.73
35.45	69.96		0.69	117.93
36.45	187.47		0.68	311.43
37.45	241.74		0.67	395.68
38.45	25.56		0.66	41.21
40.45	28.43		0.63	43.76
42.45	17.90		0.61	26.68

TOTAL VMT	3255.90	TOTAL EXHAUST EMISSIONS	6799.94
EVAPORATIVE FACTOR	0.710 g/mile	TOTAL EVAPORATIVE EMISSIONS	2311.69
GRAND TOTAL			9111.63 ($gx10^{-3}$) 10.04 (tons)
MEAN EXHAUST EMISSION FACTOR (g/mile)			2.088
MEAN TOTAL EMISSION FACTOR (g/mile)			2.798

Table C-2. AUTOMOTIVE HYDROCARBON EMISSIONS - 1980 LDV

Speed	VMT × 10^{-3}	Exhaust factor	Speed factor	Exhaust emission
9.45	43.40	1.324	1.39	79.87
11.45	16.75		1.32	29.27
12.45	72.73		1.29	124.22
13.45	55.39		1.25	91.67
14.45	53.56		1.21	85.81
15.45	71.29		1.17	110.43
16.45	64.48		1.13	96.47
17.45	18.20		1.10	26.51
18.45	105.07		1.06	147.46
19.45	121.89		1.02	164.61
20.45	80.86		0.99	105.99
21.45	111.58		0.96	141.82
22.45	154.30		0.93	189.99
23.45	42.57		0.90	50.73
24.45	59.95		0.87	69.06
25.45	195.72		0.84	217.67
26.45	127.37		0.83	139.97
27.45	228.97		0.81	245.56
28.45	134.42		0.79	140.60
29.45	154.39		0.78	159.44
30.45	129.84		0.76	130.65
31.45	72.16		0.75	71.65
32.45	288.14		0.73	278.49
33.45	30.47		0.72	29.05
34.45	263.62		0.71	247.81
35.45	248.67		0.69	260.06
36.45	334.98		0.68	301.59
37.45	49.10		0.67	43.56
38.45	28.11		0.66	24.56
39.45	37.52		0.64	31.79
41.45	20.06		0.62	16.47
42.45	136.55		0.61	110.28
43.45	33.93		0.60	26.95

TOTAL VMT	3622.04	TOTAL EXHAUST EMISSIONS	3987.06
EVAPORATIVE FACTOR:	0.298 g/mile	TOTAL EVAPORATIVE EMISSIONS	1079.37
GRAND TOTAL			5066.43(g x 10^{-3}) 5.58(tons)
MEAN EXHAUST EMISSION FACTOR (g/mile)			1.101
MEAN TOTAL EMISSION FACTOR (g/mile)			1.399

Table C-3. AUTOMOTIVE HYDROCARBON EMISSIONS - 1985 LDV

Speed	VMT x 10^{-3}	Exhaust factor	Speed factor	Exhaust emission
12.45	43.96	0.616	1.29	34.93
13.45	64.29		1.25	49.50
14.45	54.78		1.21	40.83
16.45	121.81		1.13	84.79
18.45	80.90		1.06	52.82
19.45	64.60		1.02	40.59
20.45	229.37		0.99	139.88
21.45	37.23		0.96	22.02
22.45	247.42		0.93	141.74
23.45	6.48		0.90	3.59
24.45	180.83		0.87	96.91
25.45	256.50		0.84	132.72
27.45	139.73		0.81	69.72
28.45	282.13		0.79	137.30
29.45	17.34		0.78	8.33
30.45	143.40		0.76	67.13
31.45	142.71		0.75	65.93
32.45	487.81		0.73	219.36
33.45	317.64		0.72	140.88
34.45	307.87		0.71	134.65
35.45	234.19		0.69	99.54
36.45	132.00		0.68	55.29
38.45	86.68		0.66	35.24
40.45	33.39		0.63	12.96
41.45	21.72		0.62	8.30
43.45	138.01		0.60	51.01
44.45	34.55		0.59	12.56
45.45	36.31		0.58	12.97

TOTAL VMT 3943.65

EVAPORATIVE FACTOR: 0.200 g/mile

TOTAL EXHAUST EMISSIONS 1971.49

TOTAL EVAPORATIVE EMISSIONS 788.73

GRAND TOTAL 2760.22(g x 10^{-3})

3.04(tons)

MEAN EXHAUST EMISSION FACTOR (g/mile) 0.500

MEAN TOTAL EMISSION FACTOR (g/mile) 0.700

Table C-4. AUTOMOTIVE HYDROCARBON EMISSION - 1977 HDV

Speed	VMT x 10^{-3}	Exhaust factor	Speed factor	Exhaust emission
10.45	8.07	14.631	1.36	160.58
12.45	4.88		1.29	92.11
13.45	11.32		1.25	207.30
14.45	18.99		1.21	336.19
15.45	22.62		1.17	387.22
16.45	5.23		1.13	86.47
17.45	19.98		1.10	321.56
18.45	5.80		1.06	89.95
19.45	36.78		1.02	548.89
20.45	8.80		0.99	127.47
21.45	14.36		0.96	201.70
22.45	28.17		0.93	383.30
23.45	60.61		0.90	798.11
24.45	5.71		0.87	72.68
25.45	35.63		0.84	437.89
26.45	7.31		0.83	88.77
27.45	28.27		0.81	335.03
28.45	33.27		0.79	384.55
29.45	6.85		0.78	78.17
30.45	23.42		0.76	260.42
31.45	30.89		0.75	338.96
32.45	23.20		0.73	247.79
33.45	89.74		0.72	945.35
35.45	13.81		0.69	139.42
36.45	37.01		0.68	368.22
37.45	47.71		0.67	467.69
38.45	5.04		0.66	48.67
40.45	5.61		0.63	51.71
42.45	3.53		0.61	31.50

TOTAL VMT	642.61	TOTAL EXHAUST EMISSIONS	8037.40
EVAPORATIVE FACTOR:	4.122 g/mile	TOTAL EVAPORATIVE EMISSIONS	2648.84
GRAND TOTAL			10686.24(g x 10^{-3}) 11.78(tons)
MEAN EXHAUST EMISSION FACTOR (g/mile)			12.507
MEAN TOTAL EMISSION FACTOR (g/mile)			16.629

Table C-5. AUTOMOTIVE HYDROCARBON EMISSIONS - 1980 HDV

Speed	VMT x 10^{-3}	Exhaust factor	Speed factor	Exhaust emission
9.45	8.56	13.720	1.39	163.25
11.45	3.31		1.32	59.95
12.45	14.33		1.29	253.62
13.45	10.90		1.25	186.94
14.45	10.57		1.21	175.47
15.45	14.08		1.17	226.02
16.45	12.69		1.13	196.74
17.45	3.56		1.10	53.73
18.45	20.75		1.06	301.77
19.45	24.05		1.02	336.57
20.45	16.00		0.99	217.32
21.45	21.99		0.96	289.63
22.45	30.41		0.93	388.02
23.45	8.40		0.90	103.72
24.45	11.85		0.87	141.45
25.45	38.66		0.84	445.55
26.45	25.19		0.83	286.85
27.45	45.18		0.81	502.09
28.45	26.53		0.79	287.55
29.45	30.48		0.78	326.18
30.45	25.59		0.76	266.83
31.45	14.25		0.75	146.63
32.45	56.77		0.73	568.59
33.45	6.00		0.72	59.27
34.45	51.98		0.71	506.35
35.45	56.31		0.69	533.08
36.45	66.54		0.68	620.79
37.45	9.69		0.67	89.07
38.45	5.53		0.66	50.08
39.45	7.40		0.64	64.98
41.45	3.96		0.62	33.69
42.45	26.95		0.61	225.55
43.45	6.69		0.60	55.07

TOTAL VMT	715.15	TOTAL EXHAUST EMISSIONS	8162.40
EVAPORATIVE FACTOR:	3.478 g/mile	TOTAL EVAPORATIVE EMISSIONS	2487.29
GRAND TOTAL			10649.69(g x 10^{-3}) 11.74(tons)
MEAN EXHAUST EMISSION FACTOR (g/mile)			11.414
MEAN TOTAL EMISSION FACTOR (g/mile)			14.892

Table C-6. AUTOMOTIVE HYDROCARBON EMISSION - 1985 HDV

Speed	VMT x 10^{-3}	Exhaust factor	Speed factor	Exhaust emission
12.45	8.68	13.183	1.29	147.61
13.45	12.69		1.25	209.12
14.45	26.92		1.21	429.41
16.45	24.04		1.13	358.12
18.45	15.97		1.06	223.16
19.45	12.76		1.02	171.58
20.45	45.26		0.99	590.70
21.45	7.36		0.96	93.15
22.45	48.84		0.93	598.79
23.45	1.28		0.90	15.19
24.45	35.70		0.87	409.45
25.45	50.61		0.84	560.44
27.45	27.59		0.81	294.61
28.45	55.69		0.79	579.99
29.45	3.42		0.78	35.71
30.45	28.31		0.76	283.64
31.45	28.17		0.75	278.52
32.45	96.29		0.73	926.66
33.45	62.69		0.72	595.04
34.45	60.77		0.71	568.80
35.45	46.22		0.69	420.43
36.45	26.06		0.68	233.61
38.45	17.11		0.66	148.87
40.45	6.59		0.63	54.73
41.45	4.29		0.62	35.06
43.45	27.21		0.60	215.23
44.45	6.82		0.59	53.05
45.45	7.16		0.58	54.75

TOTAL VMT	794.50	TOTAL EXHAUST EMISSIONS	8584.88
EVAPORATIVE FACTOR:	3.000 g/mile	TOTAL EVAPORATIVE EMISSIONS	2383.50
GRAND TOTAL			10968.38(g x 10^{-3}) 12.09(tons)
MEAN EXHAUST EMISSION FACTOR (g/mile)			10.805
MEAN TOTAL EMISSION FACTOR (g/mile)			13.805

APPENDIX D

POWER GENERATING DATA

Table D-1 presents a summary of data filed by Baltimore Gas and Electric Company (BGE) with the Federal Power Commission. Only boiler generating facilities are listed. Table D-2 is a more complete and recent estimate of NO_X emissions provided by the company. The locations of these generating facilities are shown in Figure D-1, along with that facility operated by Bethlehem Steel. Figure D-2 shows the estimated growth in electrical generating capacity by BGE within the AQMA. The drop in capacity within the AQMA between 1973 and 1978 results from the large, nuclear base load plant at Calvert Cliff, in St. Mary County, Maryland, coming on line during that period.

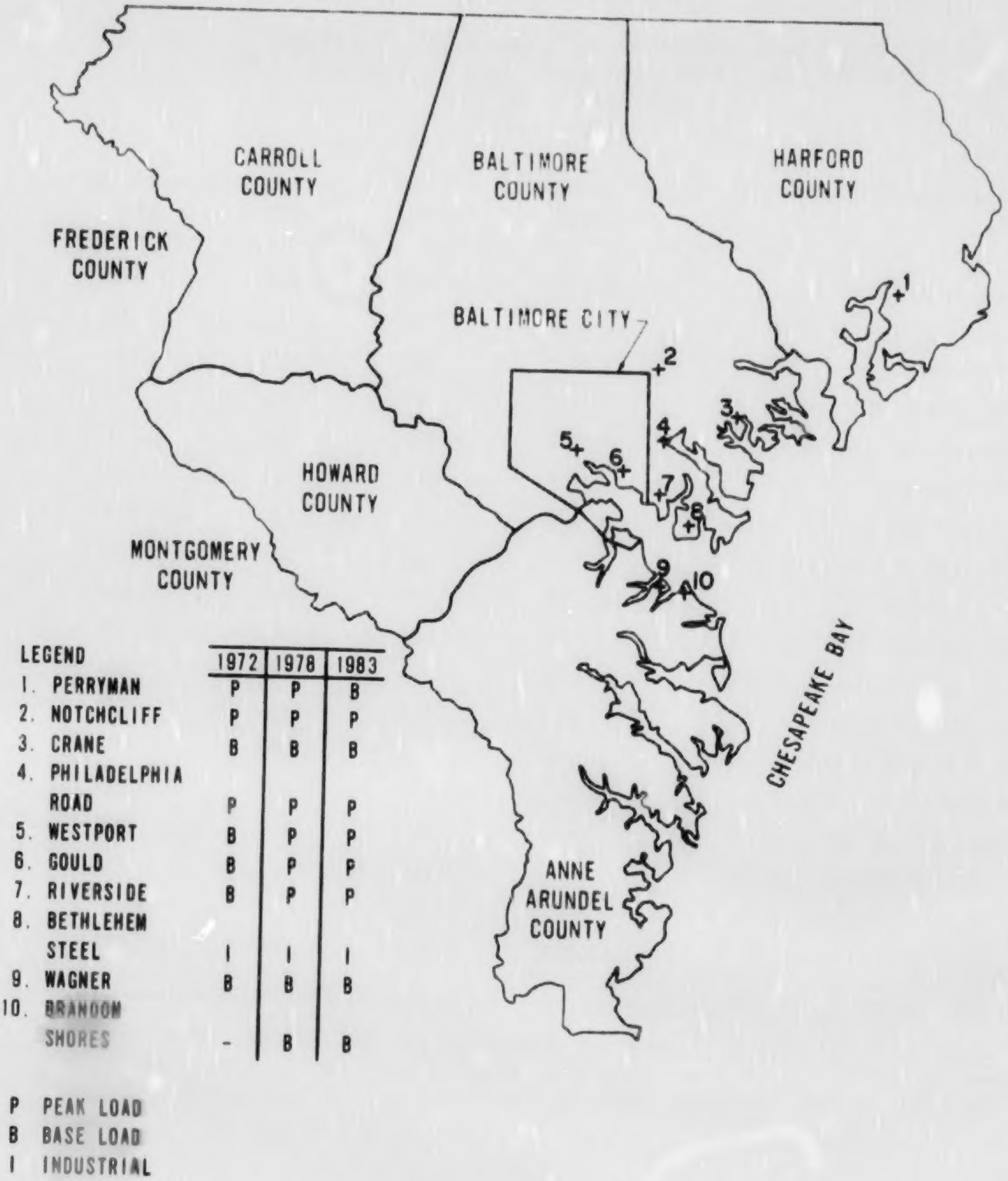
Table D-1. EMISSION INVENTORY FOR POWER PLANTS IN BALTIMORE AQMA (1,000 tons/year)

Plant	Design (MWe)	1973		1978		1983	
		TSP	SO_2	TSP	SO_2	TSP	SO_2
Wagner	991	2.13	28.95	1.35	13.76	0.96	11.28
Gould	165	0.15	3.78	0.02	0.10	0.02	0.20
Westport	259	0.22	3.78	0.01	0.03	0.03	0.18
Riverside	340	0.45	6.58	0.03	0.21	0.05	0.44
Crane	400	0.46	7.68	0.28	3.78	0.33	4.37
Brandon Shores	600	--	--	0.11	0.89	0.90	7.39
Total		3.41	50.77	1.80	18.77	2.29	23.86

Table D-2. ESTIMATED NITROGEN OXIDES EMISSIONS FROM ELECTRIC GENERATING FACILITIES IN BALTIMORE AQMA 1973 THROUGH 1985[(a)] (tons/year)

Units	1973	1975	1980	1985
C.P. Crane 1 and 2	9,152	3,150	6,525	6,525
C.P. Crane Gas Turbine	103	45	18	18
Gould Street 1, 2, and 3	2,688	591	203	269
Notch Cliff Gas Turbines	2,085	97	45	0
Perryman Gas Turbines	1,268	2,260	131	131
Philadelphia Road Gas Turbines	466	237	35	35
Riverside 1, 2, 3, 4, and 5	5,530	1,596	377	1,017
Riverside Gas Turbines	757	320	103	30
H. A. Wagner 1, 2, and 4	11,252	8,820	4,265	3,698
H. A. Wagner 3	6,966	6,903	5,112	5,607
H. A. Wagner Gas Turbine	106	40	13	13
Westport 1, 3, and 4	2,613	525	183	432
Westport Gas Turbine	242	113	78	78
Brandon Shores 1 and 2	--	--	3,909	4,250
Future 400 MW GT	--	--	--	262
Future 500 MW GT	--	--	--	328
Total	43,228	24,697	20,997	22,693

(a) Compilation of Air Pollutant Emission Factors, 2nd Edition, U.S. Environmental Protection Agency, Research Triangle Park, N.C., April, 1973, amended through September 1973, pp. 1.1-3, 1.3-2, 3.3.1-1, 3.3.1-2.


CARROLL COUNTY
BALTIMORE COUNTY
HARFORD COUNTY
FREDERICK COUNTY
BALTIMORE CITY
HOWARD COUNTY
MONTGOMERY COUNTY
ANNE ARUNDEL COUNTY
CHESAPEAKE BAY
1
2
3
4
5
6
7
8
9
10

LEGEND

	1972	1978	1983
1. PERRYMAN	P	P	B
2. NOTCHCLIFF	P	P	P
3. CRANE	B	B	B
4. PHILADELPHIA ROAD	P	P	P
5. WESTPORT	B	P	P
6. GOULD	B	P	P
7. RIVERSIDE	B	P	P
8. BETHLEHEM STEEL	I	I	I
9. WAGNER	B	B	B
10. BRANDON SHORES	-	B	B

P	PEAK LOAD
B	BASE LOAD
I	INDUSTRIAL

Figure D-1. Power generating plants BMAQMA

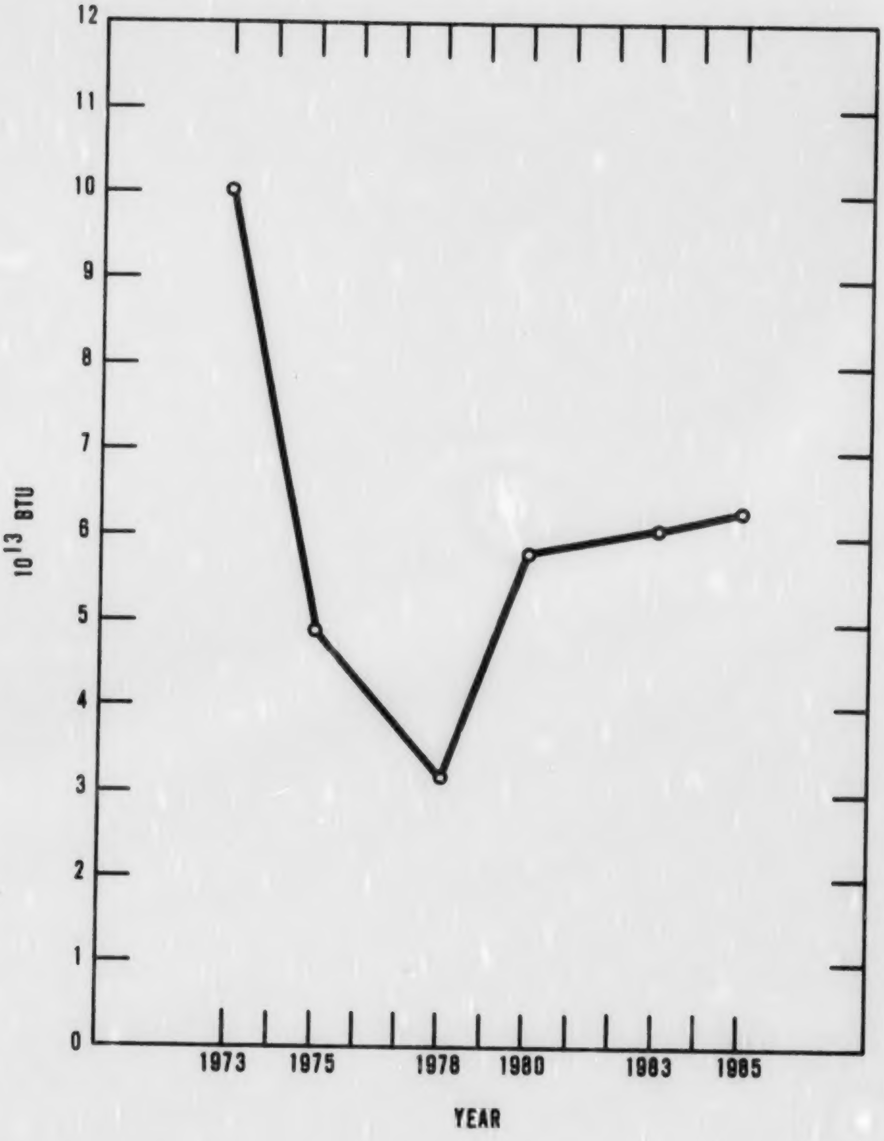


Figure D-2. Electric power generating capacity within Baltimore AQMA

APPENDIX E

INTRODUCTION

The 1970 demographic data listed in Table E-1 of this appendix represent the basic information used in the transportation analyses conducted in the Baltimore metropolitan area. The data was collected and analyzed by the Baltimore Regional Planning Council and reported in "Unified Transportation Planning Process Technical Memorandum No. 5" (October 1973). The data included in this table can be divided into two general categories--residential and non-residential.

Residential data include:

- Population;
- Residential acreage;
- Household size; and
- Dwelling units.

Non-residential data include:

- Total employment;
- Retail employment;
- Service employment;
- Office employment;
- Government employment;
- Intensive employment (manufacturing);
- Extensive employment (all other);
- Total acreage

The data are listed by Regional Planning District (RPD).

Much of this information was obtained from 1970 Bureau of Census tabulations. Those items obtained directly from the housing and population tables of the 1970 Census include Population and Household Size. Employment data were obtained from a 1970 RPC Small Area Employment File obtained from the Maryland Department of Employment and Security.

Forecasts of demographic data for 1973, 1977, 1980, and 1985 are summarized by Regional Planning District (RPD) in Tables E-2 through E-5, respectively. These forecasts were made by the Regional Planning Council Unified Transportation Planning Process and were reported in their Technical Memorandum No. 10. Residential and non-residential forecast data are presented for the same categories as for the 1970 data (Table E-1).

Development of socio-economic forecasts on a zonal basis for each alternative was accomplished by the Regional Planning Council as a two-stage process. Population and employment totals were initially allocated to Regional Planning Districts (RPD's) using an urban development allocation process based on relationships found in the 1970 base year. The second stage involved the disaggregation to the zonal level and the generation of forecasts of other socio-economic variables required for travel simulation purposes. The disaggregated data is not reported here.

The urban development allocation process used to forecast population and employment to RPD's is known as the Urban Systems Model (USM). This set of computer programs predicts the location of activities at one point in time, in contrast to allocating growth increments, as a function of a set of independent variables for that point in time. Initially, for each forecast year, the location of employment in firms of over 250 employees was established in accordance with the development patterns by means of a manual allocation process. Given the location of large employment, the USM computer model first allocated population to RPD's on the basis of:

- Observed journey-to-work relationships found in 1970.
- The specific transportation network and accessibility patterns being considered.
- The attractiveness of each RPD as defined by 1970 calibration factors and planned development densities.

Next, employment in small firms was allocated by the USM to RPD's by relating these employment locations to residential and large employment locations.

The process of allocating population and small employment was an iterative procedure whereby diminishing amounts of population and small employment were allocated until the control totals for population and small employment for the region were reached.

Table E-1. 1970 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
101	19914	1352	3.06	6508	3282	820	524	427	1110	0	401	1570
102	8382	681	3.06	2739	3536	232	1023	311	1358	174	438	1630
103	23272	2102	3.06	7605	7720	1241	956	528	2876	1208	911	2800
104	28410	911	3.06	9284	4286	1306	387	348	1164	27	1154	1430
105	38298	1268	3.06	12516	7386	1590	1018	129	3509	70	1070	1950
106	51994	2682	3.06	16992	8013	2044	1712	494	1496	384	1883	3640
107	59489	2318	3.06	19441	9887	3548	1180	292	2215	619	2033	4230
108	44053	862	3.06	14396	9297	2370	1091	207	4046	637	946	1240
109	19689	356	3.06	6434	8702	2403	427	139	2974	1467	1292	1430
110	17635	375	3.06	5763	11302	1135	935	1159	1450	4872	1311	970
111	53826	649	3.06	17590	33548	5437	5528	2189	10679	4335	5430	1660
112	22294	556	3.06	7286	4766	1318	265	144	676	1417	946	1300
113	38658	1571	3.06	12633	5986	2470	808	363	672	73	1600	2790
114	16403	752	3.06	5360	1344	870	105	34	159	5	171	1340
115	29453	487	3.06	9625	4201	668	658	82	1232	1075	486	1430
116	49198	733	3.06	16078	10187	1476	1044	65	2799	2279	2524	1370
117	103407	1300	3.06	33793	22891	3039	3127	460	10979	2206	4080	1890
118	16449	48	3.06	5392	118350	16772	15951	19997	31563	12310	21756	910
119	87165	856	3.06	28485	35113	4214	3551	623	13419	5746	7560	1820
120	56704	646	3.06	18531	16592	3805	1754	433	1987	5385	3228	1290
121	24248	464	3.06	7924	52454	1809	1476	382	8266	28955	11566	4300
122	19645	560	3.06	6420	10261	1772	413	87	2278	2687	3074	1810
123	10175	95	3.06	3325	17902	3966	510	138	1041	8468	3779	970
124	21702	195	3.06	7092	16884	1497	1514	104	1451	6985	5333	1250
125	24899	560	3.06	8137	8586	711	892	34	2333	3134	1422	1620
126	19484	499	3.06	6367	13677	1268	420	76	1122	8016	2775	3790
201	28244	2279	3.45	8187	11719	1679	784	209	6752	544	1751	8080
202	2955	290	3.45	857	13009	76	588	49	328	9744	2223	7310
203	44204	2833	3.45	12813	16786	7045	1894	597	3454	1322	2474	7110
204	11299	819	3.45	3275	4339	856	129	40	1450	1425	439	7370
205	17890	1259	3.45	5186	3113	532	369	6	884	627	695	14811
206	29208	3219	3.45	8466	5158	1074	846	168	1911	113	1046	10930
207	25016	3802	3.45	7251	2388	584	530	79	619	33	540	18990
208	9562	406	3.45	2772	2300	223	202	0	1575	0	300	5324
209	16702	0	3.45	4841	23137	24	113	43	22847	0	110	14040

Table E-1 (continued). 1970 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
210	10286	2022	3.45	2982	4427	976	258	46	495	1778	874	12810
303	3234	355	3.28	986	1005	183	151	0	157	8	506	21620
304	2243	126	3.28	664	1095	100	138	31	59	273	494	18270
305	5647	1063	3.28	1722	1036	114	203	0	138	4	577	31760
306	26433	1932	3.28	8059	6339	1183	632	85	2348	722	1369	13010
307	3174	1142	3.28	968	944	22	244	6	290	1	381	16940
308	21979	2172	3.28	6701	7345	1465	1034	215	681	1287	2663	6740
309	16047	1802	3.28	4892	14993	1508	2189	730	1523	5560	3483	10590
310	5379	1415	3.28	1640	1698	35	203	18	67	890	485	17770
311	4463	587	3.28	1361	1111	19	198	0	312	46	456	16230
312	19310	1616	3.28	5887	3101	864	458	103	1025	82	569	5970
313	24466	3073	3.28	7459	12699	2329	2493	495	1847	3350	2185	14250
314	6062	1730	3.28	1848	3374	141	230	11	2462	198	332	2820
315	70815	4545	3.28	21590	42120	9300	5555	4850	9182	5888	7345	10260
316	31118	3120	3.28	9487	6256	2559	926	389	1195	72	1115	5080
317	16914	126	3.28	5157	3617	1039	292	68	662	252	1304	14370
318	4198	689	3.28	1280	927	147	70	10	134	285	281	11810
319	48917	4120	3.28	14914	7338	1654	1134	137	2086	454	1873	8470
320	16892	1242	3.28	5150	1857	535	322	78	427	27	468	2240
321	2715	578	3.28	828	2151	91	142	0	1290	228	400	4170
322	10577	2356	3.28	3225	1874	270	244	47	134	357	772	12560
323	28164	2212	3.28	8587	27016	5514	1352	861	16512	918	1859	7270
324	32097	2359	3.28	9786	9946	2079	1357	221	4005	287	1997	7710
325	39880	2216	3.28	12158	12473	1253	875	270	1149	4668	4258	6730
326	12958	1119	3.28	3951	5435	948	286	87	331	1514	2269	3300
327	15332	975	3.28	4735	6530	833	314	96	1185	3107	995	4680
328	45773	3492	3.28	13955	6861	2087	686	264	1846	420	1558	8360
329	51022	1972	3.28	15556	10655	2839	825	348	2100	2328	2215	4480
330	34731	1366	3.28	10589	8690	3125	797	304	1155	1903	1412	5140
331	11340	1179	3.28	3457	34366	605	168	93	950	30779	1771	6170
603	17445	3068	3.59	4859	7645	1244	2943	231	1090	864	1273	18330
604	4519	680	3.59	1259	4396	64	67	9	3980	0	276	9960
605	13460	2199	3.59	3749	7850	554	754	1147	1626	2736	763	18800
606	9243	710	3.59	2575	3291	337	382	63	219	798	1492	12410
607	9086	824	3.59	2531	3420	373	209	0	671	506	1659	13820

(a) Household size
(b) Dwelling unit

Table E-2. 1973 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size$^{(a)}$	DU$^{(b)}$	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
101	20421	1375	2.81	7267	3227	804	510	425	1088	0	401	1570
102	9474	736	2.81	3372	3504	220	1016	310	1344	172	442	1630
103	23130	2102	2.81	8231	7758	1202	1077	523	2845	1197	914	2800
104	27972	991	2.81	9954	4323	1279	367	346	1139	24	1166	1430
105	38021	1268	2.81	13531	7319	1557	993	128	3493	66	1085	1950
106	52166	2692	2.81	18564	7799	1950	1667	486	1439	366	1891	3640
107	60944	2391	2.81	21688	9790	3474	1142	281	2218	630	2044	4230
108	44202	870	2.81	15730	9196	2321	1059	214	4036	628	951	1240
109	20546	363	2.81	7312	8731	2312	452	147	3022	1475	1324	1430
110	18594	412	2.81	6617	11133	1153	958	1613	1467	4608	1333	970
111	52269	649	2.81	18601	33754	5322	5394	2148	11221	4254	5416	1660
112	22179	556	2.81	7893	4660	1286	243	139	650	1402	940	1300
113	38425	1586	2.81	13674	5909	2434	789	359	644	67	1616	2740
114	16810	772	2.81	5982	1556	948	122	38	213	16	219	1340
115	29880	508	2.81	10633	4047	635	633	76	1169	1063	470	1430
116	49300	739	2.81	17544	10153	1450	1024	13	2797	2269	2550	1370
117	99326	1300	2.81	35347	29862	3641	3767	627	15120	2497	4210	1890
118	18910	49	2.81	6730	120933	16313	16176	20609	33960	12072	21802	910
119	81960	856	2.81	29167	34363	3998	3292	588	13315	5972	7650	1820
120	52919	646	2.81	18832	16221	3648	1620	414	1918	5432	3188	1290
121	23332	464	2.81	8303	53116	1758	1846	370	7446	29945	11751	4300
122	19711	564	2.81	7015	11021	1904	492	103	2287	2853	3382	1810
123	9924	95	2.81	3532	18241	4176	770	170	1030	8250	3845	970
124	21950	200	2.81	7811	18938	1882	2247	136	1553	7288	5832	1250
125	25474	589	2.81	9065	8522	731	855	30	2306	3170	1417	1620
126	19524	501	2.81	6948	13624	1278	442	78	1126	7919	2811	3790
201	30214	2477	3.17	9531	10410	1270	562	149	6423	163	1625	8080
202	3180	312	3.17	1003	14919	229	619	62	2356	9620	2033	7310
203	45845	2980	3.17	14462	17179	7241	1905	602	3483	1330	2619	7110
204	14689	1060	3.17	4634	5313	1153	191	56	1526	1883	504	7370
205	20872	1557	3.17	6584	3998	531	364	6	888	627	722	14811
206	32451	3543	3.17	10237	5417	1147	873	178	1988	130	1102	10930
207	27983	4099	3.17	8827	2517	617	541	83	654	40	582	18999
208	11358	586	3.17	3583	2341	225	202	3	1602	.3	311	5324
209	16862	16	3.17	5319	23536	40	121	45	23204	3.6	123	14040

Table E-2 (continued). 1973 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
210	11678	2162	3.17	3684	4320	956	233	42	461	1760	865	12510
303	3699	386	3.02	1225	1014	182	147	0	154	8	570	21620
304	2492	143	3.02	825	1116	94	136	29	57	293	506	15270
305	5829	1076	3.02	1930	1037	112	213	0	128	4	596	31760
306	30881	2229	3.02	10225	6660	1149	636	90	2695	705	1385	13010
307	3667	1174	3.02	1214	960	22	242	6	291	1	398	16940
308	24339	2329	3.02	8059	7430	1489	1039	217	696	1288	2700	6740
309	17928	1928	3.02	5936	15891	1554	2352	757	1516	5985	3727	10590
310	5512	1424	3.02	1825	1703	31	190	16	59	926	480	17770
311	4910	617	3.02	1626	1149	23	197	0	400	47	482	16230
312	21295	1748	3.02	7051	3145	870	458	103	1037	83	593	5970
313	28925	3460	3.02	9578	12739	2236	2400	475	1805	3631	2195	14250
314	6271	1744	3.02	2076	3432	145	230	12	2497	199	348	2820
315	71212	4572	3.02	23580	43133	8945	5558	4663	10197	6497	7272	10260
316	31699	3143	3.02	10496	6245	2546	915	387	1184	70	1144	5080
317	20821	386	3.02	6894	4080	1100	318	75	710	509	1367	14370
318	14266	694	3.02	1412	913	145	62	10	132	281	283	11810
319	50457	4208	3.02	16707	7594	1642	1121	136	2087	450	2158	8470
320	17402	1257	3.02	5762	1857	532	316	78	422	26	483	2240
321	3889	656	3.02	1288	2491	120	155	4	1356	414	442	4170
322	12894	2511	3.02	4269	1904	284	252	49	152	362	804	12560
323	30984	2409	3.02	10280	32432	6639	1815	918	20202	1100	1956	7270
324	35215	2563	3.02	11661	10744	2168	1445	280	4485	318	2049	7710
325	40095	2287	3.02	13276	12845	1287	879	274	1166	4922	4346	6730
326	12505	1119	3.02	4141	5336	917	260	77	311	1505	2266	3300
327	17120	1081	3.02	5669	7036	877	311	101	1231	3099	1398	4680
328	45667	3541	3.02	15121	6841	2066	667	263	1832	417	1591	8360
329	49861	1972	3.02	16510	10318	2775	765	333	1993	2288	2195	4480
330	34133	1366	3.02	11302	8426	3026	739	291	1059	10277	1492	5140
331	11357	1180	3.02	3761	3391	536	137	85	913	30490	1743	6170
603	20684	3313	3.31	6249	8727	1405	3099	289	1275	880	1780	18830
604	5154	744	3.31	1557	4505	82	75	12	4046	4	286	9960
605	36206	4466	3.31	10938	16233	1651	2190	1229	3017	6754	1202	18800
606	10682	854	3.31	3227	3837	420	429	70	274	980	1670	12410
607	11298	1045	3.31	3413	3363	341	187	0	734	472	1627	13820

(a) Household size
(b) Dwelling unit

Table E-3. 1973 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size[a]	DU[b]	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
101	21097	1407	2.69	7843	3153	782	490	422	1059	0	400	1570
102	10929	809	2.69	4062	3460	203	1006	308	1325	166	448	1630
103	22941	2102	2.69	8528	3153	194	1238	515	2803	1183	919	2800
104	27389	991	2.69	10182	4240	1244	345	342	1106	21	1182	1430
105	37653	1268	2.69	13997	7230	1520	959	114	3471	60	1157	1950
106	52397	2705	2.69	19478	7513	1825	1606	474	1364	343	1901	3640
107	62883	2489	2.69	23376	9662	3377	1093	265	2222	646	2060	4230
108	44400	880	2.69	16506	9060	2255	1017	191	4022	617	957	1240
109	22359	372	2.69	8312	8770	2190	485	159	3085	1485	1366	1430
110	21270	517	2.69	8439	10908	1178	988	1633	1490	4257	1362	970
111	50193	649	2.69	18659	33948	5168	5214	2092	11943	4146	5399	1660
112	22026	556	2.69	8188	4519	1244	214	131	616	1382	932	1300
113	38116	1644	2.69	14170	5805	2385	764	354	607	66	1636	2740
114	17352	800	2.69	6451	1840	1053	146	45	285	30	282	1340
115	30451	535	2.69	11320	3421	590	601	69	1085	1048	449	1430
116	49436	746	2.69	18378	10109	1414	998	60	2794	2257	2586	1370
117	93886	1300	2.69	34902	37822	4444	4620	850	20640	2885	4383	1890
118	22124	50	2.69	8225	124378	15702	16476	21425	37157	11754	21865	910
119	75021	856	2.69	27889	33362	3710	2946	6152	13175	5218	7771	1820
120	47873	646	2.69	17797	15725	3440	1443	389	1826	5495	3134	1290
121	22110	464	2.69	8219	54000	1689	2340	354	6352	31266	11999	4300
122	19799	568	2.69	7360	12033	2080	597	124	2365	3073	3794	1810
123	9590	95	2.69	3565	18694	4455	1117	214	1015	7961	3932	970
124	22281	206	2.69	8283	21678	2395	3224	178	1689	7692	6499	1250
125	26242	627	2.69	9755	8436	679	807	24	2269	3217	1409	1620
126	19576	857	2.69	7277	13553	1291	470	80	1131	7791	2859	3790
201	32840	2739	3.04	10803	8665	726	267	68	5985	163	1456	8080
202	3480	343	3.04	1145	17467	434	661	79	5058	9456	1780	7310
203	45845	2980	3.04	15081	17179	7241	1905	602	3483	1330	2619	7110
204	13706	1060	3.04	4509	5313	668	191	56	1526	1883	592	7370
205	24847	1954	3.04	8173	3181	530	358	6	894	627	759	14811
206	36775	3975	3.04	12097	5763	1245	909	190	2089	152	1178	10930
207	31940	4495	3.04	10507	2693	661	557	87	700	50	638	18990
208	13753	825	3.04	4524	2395	228	202	1	1637	1	326	5324
209	17076	37	3.04	5617	24069	59	131	49	23681	8	140	14090

Table E-3 (continued). 1977 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employ-ees	Intensive	Extensive	Total area (acres)
210	13533	2348	3.04	4452	4177	932	201	38	417	1737	854	12510
303	4320	427	2.09	1495	1027	182	141	0	149	8	547	21620
304	2824	164	2.09	977	1143	86	134	27	55	321	522	15270
305	6072	1092	2.09	2101	1038	110	190	0	114	3	621	31760
306	36811	2624	2.09	12737	7087	1103	640	97	3158	682	1406	13010
307	4311	1218	2.09	1492	981	23	238	6	293	1	420	16940
308	27303	2539	2.09	9447	7544	1522	1047	221	717	1289	2749	6740
309	20435	2096	2.09	7071	17089	1615	2570	798	1507	6551	4052	10590
310	5689	1435	2.09	1969	1709	25	174	14	48	975	474	17770
311	5506	656	2.09	1905	1199	28	197	1	411	47	516	16230
312	23941	1924	2.09	8284	3203	879	458	104	1053	84	625	5970
313	34870	3768	2.09	12066	12793	2113	2276	446	1749	4000	2207	14250
314	6550	1762	2.09	2266	3509	151	231	13	2545	201	370	2820
315	71742	4607	2.09	24824	44483	8472	5562	4413	11551	7309	7174	10260
316	32473	3174	2.09	11236	6229	2528	900	384	1169	66	1182	5080
317	26030	734	2.09	9007	4697	1180	353	85	773	853	1452	14370
318	4356	699	2.09	1507	895	143	51	9	130	777	285	11810
319	52509	4325	2.09	18169	7935	1626	1103	134	2089	446	2537	8470
320	18082	1278	2.09	6257	1857	528	307	77	415	26	504	2240
321	5454	761	2.09	1887	2943	159	171	8	1445	663	497	4170
322	15983	2717	2.09	5530	2010	302	264	51	177	370	848	12560
323	34744	2661	2.09	12022	39652	8140	1966	995	25123	1343	2086	7270
324	39394	2836	2.09	13631	11809	2288	1563	388	5125	358	2117	7710
325	42379	2383	2.09	14664	13340	1332	883	278	1188	5260	4399	6730
326	11900	1119	2.09	4118	5204	877	225	63	285	1493	2261	3300
327	19237	1222	2.09	6656	7710	936	349	108	1293	3089	1935	4680
328	47624	3607	2.09	16479	6815	2037	641	260	1814	413	1649	8360
329	48314	1972	2.09	16718	9942	2689	685	313	1850	2236	2169	4480
330	33336	1366	2.09	11535	8066	2894	663	275	930	1889	1415	5140
331	12380	1181	2.09	3938	33295	445	102	75	864	30104	1705	6170
603	25009	3461	3.16	7914	10171	1620	3308	365	1521	900	2456	18830
604	5999	828	3.16	1898	4649	106	84	17	4134	8	300	9960
605	66743	7363	3.16	21121	27409	3113	4106	1338	4872	12112	1788	18800
606	12599	1045	3.16	3987	4566	520	491	79	346	1222	1907	12410
607	14246	1340	3.16	4508	3286	297	159	0	819	427	1585	13820

(a) Household size
(b) Dwelling unit

Table E-4. 1980 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
101	21604	1430	2.60	8309	3098	765	476	420	1037	0	400	1570
102	1202	864	2.60	4624	3428	191	999	307	1311	168	452	1630
103	22799	2102	2.60	8769	7847	1112	1339	510	2772	1172	922	2800
104	26951	991	2.60	10366	4177	1217	327	340	1081	18	1194	1430
105	37376	1268	2.60	14375	7163	1490	934	108	3455	55	1121	1950
106	52509	2715	2.60	20219	7299	1731	1561	466	1307	325	1909	3640
107	64338	2562	2.60	24745	9565	3303	1055	254	2225	657	2071	4230
108	44549	887	2.60	17134	8959	2206	985	184	4012	608	964	1240
109	22545	379	2.60	8671	8799	2098	510	167	3133	1493	1398	1430
110	20831	500	2.60	8012	10739	1196	1011	1648	1507	3993	1384	970
111	48636	649	2.60	18706	34119	5053	5080	2051	12485	4065	5385	1660
112	21911	556	2.60	8427	4413	1212	192	126	590	1367	926	1300
113	37883	1621	2.60	14570	5728	2349	745	330	579	53	1652	2740
114	17759	820	2.60	6830	2052	1131	163	49	339	40	330	1340
115	30878	556	2.60	11876	3687	557	576	63	1022	1036	433	1430
116	49538	752	2.60	19053	10075	1388	978	58	2792	2247	2612	1370
117	89805	1300	2.60	34540	43793	5046	5260	1017	24781	3176	4513	1890
118	24534	51	2.60	9436	126961	15243	16701	22037	39554	11515	21911	910
119	69816	856	2.60	26852	32612	3495	2687	507	13071	4991	7861	1820
120	44088	646	2.60	16957	15354	3283	1309	370	1757	5542	3093	1290
121	21194	464	2.60	8152	54662	1538	2710	342	5532	32256	12184	4300
122	19865	572	2.60	7640	12793	2212	676	146	2424	3239	4102	1810
123	9339	95	2.60	3592	19033	4665	1377	246	1004	7743	3998	970
124	22529	210	2.60	8665	23732	2780	3957	211	1791	7995	6998	1250
125	26817	656	2.60	10314	8372	639	770	19	2242	3253	1404	1620
126	19616	505	2.60	7545	13500	1302	492	82	1135	7694	2895	3790
201	34810	2936	2.93	11880	7336	317	45	8	5656	0	1330	8080
202	3705	365	2.93	1265	19377	587	692	92	7084	9332	1590	7310
203	49673	3323	2.93	16953	18097	7698	1932	614	3549	1347	2957	7110
204	19321	1622	2.93	6594	7586	1846	377	94	1702	2950	657	7370
205	27829	2252	2.93	9498	3201	529	353	6	898	627	786	14811
206	40018	4299	2.93	13658	6022	1318	936	200	2165	169	1234	10930
207	34907	4792	2.93	11637	2825	694	568	91	735	57	680	18990
208	15549	1005	2.93	5307	2435	230	202	1	1664	1	337	5324
209	17236	53	2.93	5883	24468	76	138	51	24038	12	153	14090

Table E-4 (continued). 1980 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
210	14925	2487	2.93	5094	4070	913	176	34	383	1719	845	12510
303	4785	458	2.79	1715	1036	181	137	0	146	8	564	21620
304	3073	181	2.79	1101	1164	80	132	24	53	341	534	15270
305	6254	1105	2.79	2242	1039	107	185	0	104	3	640	31760
306	41259	2921	2.79	14788	7408	1069	644	102	3505	665	1423	13010
307	4799	1250	2.79	1720	997	23	236	6	294	1	437	16940
308	29845	2696	2.79	10697	7629	1546	1052	-223	732	1290	2786	6740
309	22316	2222	2.79	7999	17987	1661	2733	821	1500	6976	4296	10590
310	5822	1444	2.79	2087	1714	21	161	12	40	1011	469	17770
311	5954	686	2.79	2134	1237	32	196	1	419	48	541	16230
312	25928	2056	2.79	9292	3247	885	458	104	1065	86	649	5970
313	39329	4066	2.79	14096	12833	2020	2183	428	1707	4278	2217	14250
314	6759	1776	2.79	2422	3567	155	231	13	2880	202	386	2820
315	72140	4634	2.79	25857	45495	8117	5566	4227	12566	7918	7101	10260
316	33054	3197	2.79	11847	6218	2514	889	382	1158	64	1211	5080
317	29937	994	2.79	10730	5160	1241	379	92	823	1110	1515	14370
318	4424	704	2.79	1586	881	141	43	9	128	273	287	11810
319	54049	4413	2.79	19372	8191	1614	1090	133	2090	442	2822	8470
320	18593	1293	2.79	6664	1857	525	301	77	410	25	519	2240
321	6628	839	2.79	2376	3283	188	184	12	1511	849	539	4170
322	18300	2872	2.79	6559	2091	316	272	53	195	375	880	12500
323	37564	2849	2.79	13464	45068	9265	2229	1052	28813	1826	2183	7250
324	42522	3040	2.79	17033	12607	7377	1651	416	5605	389	2169	7710
325	43450	2454	2.79	15573	13712	1366	887	282	1204	5513	4460	6730
326	11447	1119	2.79	4103	5105	846	199	53	265	1484	2258	3300
327	20825	1328	2.79	7464	8215	980	304	113	1339	3081	2338	4680
328	48418	3656	2.79	17354	6795	2016	622	259	1800	410	1688	8360
329	47154	1972	2.79	16901	9636	2625	625	298	1743	2196	2149	4480
330	32738	1366	2.79	11605	7796	2795	605	262	834	1883	1417	5140
331	11397	1182	2.79	4085	32836	376	74	67	827	29815	1677	6170
603	28251	3886	3.05	9263	11253	1781	3464	423	1706	916	2963	18830
604	6634	892	3.05	2175	4758	124	92	20	4200	12	310	9960
605	89279	9577	3.05	29272	38792	4210	5542	1420	6263	16130	2227	18800
606	14038	1189	3.05	4603	5112	598	538	80	401	1404	2085	12410
607	16458	1561	3.05	5396	3229	265	136	0	882	393	1557	13820

(a) Household size
(b) Dwelling unit

Table E-5. 1985 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size [(a)]	DU [(b)]	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
101	22117	1426	2.54	8707	3239	798	492	424	1085	3	435	1570
102	12057	866	2.54	4747	3584	234	1013	312	1351	176	499	1630
103	23144	2105	2.54	9112	8033	1158	1384	516	2810	1185	980	2800
104	27654	1002	2.54	10887	4273	1239	335	341	1102	20	1237	1430
105	38092	1288	2.54	14997	7251	1508	944	112	3456	58	1174	1950
106	53013	2735	2.54	20872	7527	1788	1573	470	1343	326	2017	3640
107	65599	2618	2.54	25826	11846	3817	1222	335	3462	769	2241	4230
108	45197	886	2.54	17794	9154	2270	1016	194	4032	620	1022	1240
109	23084	379	2.54	9088	9034	2185	540	182	3382	1301	1444	1430
110	20768	500	2.54	8176	10725	1217	1024	1644	1510	3910	1345	970
111	50348	649	2.54	19822	35945	5340	5869	2513	12721	4018	5484	1660
112	23589	588	2.54	9287	4530	1234	202	130	610	1379	974	1300
113	38439	1663	2.54	15133	5957	2411	759	357	625	64	1741	2740
114	18269	845	2.54	7193	2184	1169	175	57	372	47	366	1340
115	30823	554	2.54	12135	3829	579	589	67	1071	1046	477	1430
116	49445	746	2.54	19467	10436	1503	1030	71	2842	2284	2704	1370
117	88471	1300	2.54	34831	51203	6027	6642	1930	28307	3627	4669	1890
118	26112	52	2.54	10280	138581	15255	17235	29112	43485	kk563	21930	910
119	70337	856	2.54	27692	33981	3730	2939	545	13642	5142	7984	1820
120	44186	641	2.54	17396	15495	3309	1346	376	1700	5504	3191	1290
121	20622	464	2.54	8119	57582	1644	3326	344	5481	34375	12410	4300
122	19567	568	2.54	7703	15414	2725	1131	202	2503	4141	4717	1810
123	9280	95	2.54	3654	18664	4742	1338	252	1025	7292	4015	970
124	21698	205	2.54	8543	24355	2912	4176	222	1808	8143	7095	1250
125	27191	675	2.54	10705	8654	689	829	28	2264	3310	1473	1620
126	19519	503	2.54	7685	14493	1440	752	101	1174	7886	3206	3790
201	36350	3089	2.86	12710	7890	385	114	10	5814	50	1517	8080
202	3898	385	2.86	1363	21221	893	1022	145	7848	9562	1752	7310
203	52399	3519	2.86	18321	20705	8565	2511	801	4096	1721	3011	7110
204	22705	1960	2.86	7939	8228	1981	446	115	1733	3017	916	7370
205	36660	3136	2.86	12818	3840	724	427	30	1067	669	924	14811
206	50403	5340	2.86	17633	8446	1914	1517	299	3003	308	1404	10930
207	39510	5252	2.86	13815	3108	775	594	100	803	74	763	18990
208	17846	1235	2.86	6240	3298	414	284	26	2096	43	436	5324
209	18488	178	2.86	6464	26838	91	145	53	26365	15	168	14040

Table E-5 (continued). 1985 DEMOGRAPHIC DATA BY REGIONAL PLANNING DISTRICT FOR THE BALTIMORE REGION

RPD	Population	Res. area (acres)	HH size(a)	DU(b)	Total employment (persons)	Retail employees	Service employees	Office employees	Gov't employees	Intensive	Extensive	Total area (acres)
210	17481	2752	2.86	6112	5365	1148	372	64	540	1984	1258	12510
303	5857	530	2.72	2153	1131	192	137	1	173	10	618	21620
304	4077	248	2.72	1449	1396	103	137	29	93	347	687	15270
305	6321	1109	2.72	2324	1071	106	177	0	101	3	685	31760
306	50165	3514	2.72	18443	10225	2054	953	221	4269	1122	1606	13010
307	6924	1391	2.72	2546	1364	72	254	12	500	10	516	16940
308	31048	2776	2.72	11415	8015	1677	1089	237	806	1323	2884	6740
309	23459	2298	2.72	8625	19408	2155	2849	858	1903	7225	4417	10590
310	7233	1538	2.72	2659	1749	22	156	12	41	1017	501	17770
311	10407	983	2.72	3826	1637	132	234	12	536	69	655	16230
312	32700	2508	2.72	12022	3922	1190	519	123	1195	123	773	5970
313	42121	4228	2.72	15486	14629	2389	2471	146	2278	4408	2451	14250
314	6963	1790	2.72	2560	3632	175	236	646	2574	206	426	2820
315	73929	4753	2.72	27180	47931	8696	6084	15	13209	8209	7242	10260
316	32757	3191	2.72	12043	6543	2604	914	4434	1226	83	1315	5080
317	34060	1269	2.72	12522	5915	1392	440	393	916	1153	1904	14370
318	4489	708	2.72	1650	882	140	35	109	128	276	301	11810
319	57568	4606	2.72	21165	9498	2071	1215	9	2508	564	2924	8470
320	19571	1340	2.72	7195	1937	536	302	173	425	27	569	2240
321	7081	869	2.72	2603	4644	491	238	78	2233	1014	634	4170
322	20828	3041	2.72	7657	3258	477	393	35	365	668	1260	12360
323	40276	3020	2.72	14807	46544	9601	2300	95	29621	1607	2292	7270
324	44543	3158	2.72	16376	15392	2526	1844	1093	5683	438	2264	7710
325	45197	2570	2.72	16616	15323	1878	1021	637	1403	6014	4650	6730
326	11659	1119	2.72	4286	5612	926	243	485	317	1508	2550	3300
327	22307	1427	2.72	8201	8866	1365	427	69	1450	3420	2251	4680
328	54830	4074	2.72	20158	7173	2127	657	132	1874	431	1811	8360
329	47492	1972	2.72	17460	9876	2678	635	273	1787	2218	2258	4480
330	33274	1366	2.72	12233	8032	2848	621	299	902	1891	1512	5140
331	11569	1219	2.72	4253	33007	362	62	258	822	30049	1644	6170
603	34840	4406	2.98	11691	12849	2205	3501	69	2510	958	3166	18830
604	12780	1506	2.98	4288	5739	1213	228	510	4478	85	386	9960
605	95520	10094	2.98	32054	38249	4223	5750	82	6241	18245	2249	18800
606	25198	2305	2.98	8456	7801	1336	976	1541	628	2047	2671	12410
607	25350	2450	2.98	8507	5055	691	382	141	1106	918	1905	13820
								53				

(a) Household size
(b) Dwelling unit

APPENDIX F

CONTROL MEASURES

POTENTIAL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Domestic and Commercial Heating

Improve Domestic and Commercial Building Insulation - Improving the building code specifications for insulation of domestic and commercial structures would bring about a substantial saving in B.T.U.'s.

Control Room Temperature for Air Conditioning and Heating - Central Air Conditioning represents over 25 percent of the annual residential electrical power consumption.

Realizable savings from reduction of the thermostat set-point is about one to two percent for each degree of reduction. Hittman cites a Honeywell study showing that setting the thermostat back from 75° to 68° for eight hours each night would result in an 11 percent savings in heat requirements in the Baltimore region.

Concentrate New Development at Densities Which Allow for Measures to Reduce Emissions Per Capita or Per Unit of Production - Increasing multi-family housing (as opposed to detached units), operating fewer larger industrial and power generation facilities (instead of many small ones), and carefully locating new sources may result in reduced emissions per capita through economies of scale providing increased feasibility for new control equipment, as well as increased operating efficiencies.

Reduce Window Area - Infiltration of air around windows and doors and through gaps in walls, floors, and ceilings insulation constitutes 55 percent of the total "load factor" that can be counteracted by the heating system and 42 percent of the load factor for the cooling system.

Increase Fuel Costs - Higher cost of fuel would force consumers to conserve but the regressive nature of such costs to individuals with low incomes should be considered.

Diurnal Room Temperature - A substantial savings in fuel demand could be gained by introduction of diurnal room temperature.

Reduce Ash Content of Fuel - Processing of fuel to reduce the amount of ash content would reduce the amount emitted during ignition.

Improve Furnace Design - Increasing the efficiency of furnace combustion by improving design specification could have an overall effectiveness of from 5 to 10 percent.

Improve Maintenance of Heating System - Building codes if amended to include more frequent inspections of heating systems to enforce a higher degree of efficiency could realize a 5 to 10 percent effectiveness.

Modify Pilot Light - Pilot lights in gas appliances annually use eight percent total gas consumed. Substituting electrical ignitors for pilot lights, together with better oven insulation, could save 20 to 30 percent of the energy consumption of a gas kitchen range.

Design Home Heating and Air Conditioning System as a Unit - A greater percentage of efficiency is obtained by use of a bi-modal climate control unit as a means of home temperature control. A 2 percent range of effectiveness is possible with such systems.

Orientation of Buildings and Windows - A modification of the designed building and window orientation can effectively reduce heating and air conditioning demand from 2 to 5 percent.

Install Control Devices on Small Combustion Units - The effectiveness of implementing this program ranges from 50 to 100 percent depending on the degree to which it is enforced. Changing the design specifications to modify units with control equipment would be the most effective method of implementation. An alternate approach is the addition of a "black box" such as a high efficiency cyclone or main baghouse.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Industrial Process and Heating

Reduce Demand for Industrial Products - By far, the most significant sources of particulates in the Baltimore AQMA are the industrial process emissions. Furthermore, additional industrial sources are not easy to identify, quantiate, or control. As discussed, the background levels of particulates ranged around 40 $\mu g/m^3$; therefore, only about 20 $\mu g/m^3$ of air quality are available to disperse and dilute particulate emissions in the Baltimore metropolitan area.

Assuming that the emission inventory missed some of the sources, or assuming that the pollution sources discharged more than is credited, the control measures may or may not achieve the goal of maintaining the NAAQS.

Industrial sources accounted for 55 percent of the total particulate emissions in the Baltimore AQMA in 1973. In the study reported on herein, it was projected that in 1985 industrial sources would still account for 50 percent of the total. To further reduce these process emissions will require application of more stringent emission standards. The Environmental Protection Agency is developing New Source Performance Standards for various classes of industry which will require application of the best available control technology.

To carry out a more thorough analysis of the potential control for industrial process emissions would require an analysis specific by industry class. In this AQMA, it also would be possible to look carefully at the major industrial sources when the final AQMP is prepared.

Exclude High Pollutant Sources from AQMA - See Particulates, Stationary Sources.

Modify Production Hours - A decrease in the production hours per week through local ordinances would force an industry to shorten work shifts to match output. The loss of income for the workers would probably outweigh the benefits derived through possible 2 percent effectiveness range.

Modify Raw Material Inputs - Improving raw material specifications in industrial processing would have a potential range of effectiveness of from 2 to 5 percent. Selection of raw materials of high grade which will produce less residuals during process should be used.

Recycle Residuals Back Into Production Process - Residuals which are a byproduct of the industrial process in many cases with the aid of control equipment can be recycled back into the industrial process for reuse. In some instances this represents a savings to the industry to raw materials that without recycling are lost in the process.

An emission charge is one form of incentive for industry to recycle residuals.

Improve Product Efficiencies - See particulates, Power Plants

Modify Production Output - See modify Production hours

Improve Collection Efficiency - See Particulates, Power Plants

Predict Alerts - The capability to predict alerts would in effect allow emergency measures to be put into action before the level of pollution reached a dangerous level.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Power Plants

Utilize Daylight Savings Time - Congress passed legislation this past winter which made daylight savings time mandatory year round until 1975. The percent range of effectiveness ranges from 1 to 2 percent.

Congress recently passed legislation that will reinstate standard time on a limited basis. This action was taken due to the hazards to school children traveling in early morning darkness.

Increase Electric Rates for Large Users - Restructuring the rate scale for large users could have an effectiveness rate of from 2 to 5 percent.

Improve Domestic and Commercial Building Insulation - See Particulates, Domestic and Commercial Heating

Improve Efficiency of Electrical Appliances - Appliances are becoming more energy consumptive. For example, "Frostless" refrigerators consume 30 percent more energy than do manual models. Surely the energy crisis has shown the need for energy efficient appliances.

Control Room Temperature for Heating and Air Conditioning - See Particulates, Domestic and Commercial Heating.

Ration Electricity - Growth plans for Baltimore Gas & Electric Company (BG&E), as filed with the FPC, show a substantial decline between 1973 and 1975 in electricity to be generated in the AQCR. After 1975, however, energy consumption for satisfying generation requirements is projected to increase from about 3 to over 10 x 10^3 BTU by the 1985 date.

As a last recourse, rationing of electricity could be employed on a scheduled diurnal basis or in periods of usage such as during the summer air conditioning season.

Move Power Plants Outside of Region - The resulting decline of emissions from such a drastic course of action in cases other than those involving marginal operations makes this measure cost prohibitive.

Surround Power Plants With Land Use Buffers - Providing land use buffer zones around power plants would prevent sensitive receptors such as hospitals, schools, convalescent homes, etc. from locating too close.

Utilize Storage or Peak Shaving With Clean Fuel - Having the potential to use a clean fuel during demand peaks would significantly alter emission rates. Using hydro electric power from pump storage facilities is one method that could be utilized.

Limit Use in Areas or Time to Even Out Demand - See Ration Electricity.

Reduce Ash Content of Fuel - See Particulate Control, Domestic and Commercial Heating.

Convert to Clean Fuel - The simplistic approach is to convert all generation from coal and heavy oil to natural gas. However, because of the energy crises, there is not enough gas or oil to meet today's energy requirements and utilities are requesting a change back to coal.

Generate More Power In Larger Facilities - Concentrating particulate emissions would result from operating fewer but larger generating facilities.

Use Total Energy Systems - Utilization of individual electric power producing units for facilities such as shopping centers and utilize by-products such as waste heat for space heating.

Reduce Transmission Losses - By improving transmission insulation and using higher voltage levels a greater percentage of generated electrical power would not be lost through transmission. This in turn would cause less demand on power generation.

Improve Control Equipment - The EPA has promulgated "New Source Performance Standards for Power Plants" above a certain size. In establishing the emission limits, EPA utilizes the best available control technology which can be demonstrated to the industry. Because any new plant of BG&E will have to comply with the NSPS, it would not appear that this control measure offers much hope of reducing emissions from power plant stacks below the limits now specified by EPA. The technology might be promoted to increase collector efficiencies even further; however, its application in the 1975-1985 time frame is doubtful.

Improve Collection - See Improve Control Equipment.

Increase Actual Stack Height - Use of tall stacks tends to decrease ground level concentrations of suspended particulates. The effective height of the effluent plume from a power plant depends on physical stack height as well as the temperature and velocity of the exhaust gases. Generally not much improvement will be made to an existing plant to change stacks or stack conditions; however, design specifications on new plants can be useful in achieving the desired end result.

Increase Effective Stack Height - See Increase Actual Stack Height

Utilize Intermittent Control with Weather Conditions - Depending upon weather conditions further controls will be used when probable alerts are predicted or increasing concentrations are monitored.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Transportation

Light Duty Vehicles, Heavy Duty Vehicles - Refer to measures to reduce emissions from light duty vehicles and heavy duty vehicles.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Fugitive Dust

Reduce Demand for Transportation, Construction, Agriculture and Other Activities - The fugitive dust problem in the Baltimore AQMA is complex. Several outlying counties have a quarry dust, agricultural and unpaved road generation whereas Baltimore Center City has construction and transportation generation sources.

Limit Agricultural Activities During Dry Weather - Control of agricultural Activities by local ordinances during dry weather would eliminate a significant amount of fugitive dust during dry warm weather months. The reduction in crop output during extended period of dry weather must be considered.

Limit Activity on Unvegetated Lots - Telling the local sand lot team they cannot use the ball field would be unrealistic and unpopular, but restriction of lots to off road vehicles should be considered if a 2 to 5 percent effectiveness is to be gained.

Modify Tire and Brake Design Wear - This measure requires the implementation of basic and applied research and development programs and should probably be sponsored by the Federal Government.

Eliminate Unpaved Parking Lots - Tax incentives would be the more effective program to eliminate unpaved parking lots as fugitive dust generation sites.

Control Unpaved Streets - Limiting access as well as speed would be an effective means of controlling unpaved streets which represent a major source of fugitive dust. By implementing a street control program a 25 to 50 percent rate of effectiveness could be obtained. Studies show that dust emissions increase at a rate approximately proportional to increase in vehicle speed and directly proportional to the number of vehicles.

Plant Cover on Vacant Lots - See limit activity on unvegetated lots.

Control Construction Sites - Several methods have been employed to reduce the emission of dust from construction sites including watering, chemical stabilization of cuts and fills, treatment of temporary access roads to main thoroughfares, and minimizing the period during which cleared and regraded lands are exposed. Watering of construction sites has produced a wide variation in apparent control efficiencies of 30 to 60 percent reductions due mainly to the highly variable nature of the emission sources.

Limit Speed on Unpaved Roads - See Control Unpaved Streets

Control Open Body Vehicles - Large open body vehicles (e.g., dump trucks) carrying full loads of dirt from pick up site to unloading, generate considerable amounts of fugitive dust while in transit. A simple method of curtailing this emission source is to cover the load with a heavy cloth material such as canvas. Many states already require this by law. This simple inexpensive procedure can have an effectiveness range of 10 to 25 percent.

Control Deposition on Roads - Material collected on construction vehicles from project sites usually cause deposits to build up on streets as the traffic moves in and out. Automotive vehicles in turn cause a further dispersion of the material and the cycle continues until the deposited material washed away by rain or the construction is complete. If ordinances were passed that would require these vehicles to be washed down upon leaving the sites a 10 to 25 percent range of effectiveness could be realized.

POTENTIAL CONTROL MEASURES FOR MONITORING AMBIENT AIR QUALITY STANDARDS FOR SUSPENDED PARTICULATES

Particulate Land Use Measures

Exclude New Sources from Selected Hot Spots - Areas which have been designated as high areas of pollution should be excluded from any consideration of new development that might further degrade the ambient air quality of the region.

Concentrate new development at densities which allow for measures to Reduce Emissions per Capita or per Unit - See Particulates, Domestic and Commercial Heating.

Control Existing Uses - Control of particulate emissions from individual sources can still leave "hot spots" resulting from accumulated emissions from current activities. Zoning and land use controls afford only limited opportunity for removing such residuals.

Regulate Timing of New Development - A group of controls can be utilized to regulate this timing of new development. This becomes significant in its relationship to the scheduling of transportation and other public improvements and of the predicted time of effectiveness of other air quality maintenance measures.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR HYDROCARBONS

Non-Automotive Sources

Reduce Demand for Reactive Hydrocarbon Solvents - Through taxes and fees, a reduction in reactive hydrocarbon solvents could be initiated to reduce emissions from these sources from 25 to 50 percent.

Improve Methods of Bulk Storage - It should be noted that the measures discussed elsewhere which might be used to reduce automobile hydrocarbon emission through reduced travel and more efficient engines would directly affect the emissions from bulk storage. If less gasoline is used, less bulk storage requirements and a reduction in gasoline handling would result; therefore, fewer emissions would result. It will be assumed that the reduction in emissions attributable to bulk storage will decrease in proportion to the decrease in utilization of gasoline which results from other measures.

One additional measure available to further reduce emissions from bulk storage sources comprises the reduction of gaseous leakage. New regulations for bulk storage coupled with frequent inspections could reduce the emissions. A floating roof or a vapor recovery system could be required on bulk storage facilities to accomplish this goal. All new bulk storage units of 65,000 gallons or greater capacity, in accordance with new source performance standards, are required to have such systems.

Improve Service Station Storage - As in the reduction of hydrocarbon emissions from bulk storage, the emissions from service station pumps and terminal loading would be reduced proportionately to the reduction in usage.

Measures to reduce the number of fuel-handling operations can also be taken to further reduce emissions attributable to this source. The provision of larger gasoline tanks, tank trucks, and service station storage tanks would reduce the number of operations at the pumps and terminals. Coupled with this would be a requirement to produce a method of pressure feed or vacuum feed for the transfer of gasoline. This method would serve two purposes in that it would reduce the time of operation and would require a closed system which would reduce evaporation and spillages.

As with other gasoline storage and handling operations, the reduction in gasoline consumption will reduce the emissions from service station storage by way of the reduced number of storage facilities. Also, the introduction of vapor recovery devices and floating roof would reduce emissions from storage tanks. This could be accomplished through new state and local regulations coupled with frequent inspections.

Control Power Plant Emissions - See Particulates, Power Plants

Industrial Process Heating - Three other sources of hydrocarbon emissions will, in 1985, produce 5.6 percent of the total hydrocarbon emissions inventory, i.e., industrial process heating (3.4 percent), miscellaneous gasoline engines (1.8 percent) and refuse incineration (0.4 percent). The first of these is most difficult to control; significant reduction would entail process changes for individual industrial operations, which could entail a long and difficult procedure with questionable effectiveness.

Miscellaneous Gasoline Engines - Several measures can be applied to reduce the hydrocarbon emissions from miscellaneous gasoline engines. These include the banning of gasoline powered mowers through implementation of a substantial fee, or the application of emissions control regulations to all gasoline engines. The periodic banning of gasoline-powered engines to attain episodic control is a feasible procedure.

Refuse Incineration - In the development of the 1985 projections, it was assumed that no new sources of incineration would be permitted in the region. The reduction in emissions resulting from incineration of solid waste can be achieved by more complete incineration, however, this will produce only marginal improvements in what is already a minor source.

POTENTIAL CONTROL MEASURES FOR MAINTAINING AMBIENT AIR QUALITY STANDARDS FOR NON-AUTOMOTIVE SOURCES

Mobile Sources

Controls on Diesel and Shipping - See Heavy Duty Vehicles

Reduce Demand on Diesel and Shipping - The growth of the trucking and shipping industries and the lack of controls on diesel engines accounts for the increased share of hydrocarbons emissions attributable to these sources (1.9 percent in 1972 to 5.5 percent in 1985) even though the increase in tons per three hour a.m. peak increases at a lesser rate (1.01 in 1972 to 1.35 tons in 1985). Any policy which would reduce the requirement for the transportation of goods to the region or within the region would in turn reduce the demand for the operation of diesel-powered engines and thereby reduce the hydrocarbon emissions.

One means of furthering this objective is through land use controls which keep transportation terminals and industrial/commercial users of diesel transportation in proximity to each other. There are, of course, basic economic factors acting to bring this about--the concentration of industry and warehousing in the harbor area is an example--but proper provision in the land use plan can ensure that the market has no problems in finding optimum locations which will reduce diesel vehicle miles travelled. This measure can be expected to reduce hydrocarbon emissions by a small amount.

Reduce Emissions from Diesel Engines - During the past decade, diesel engines have not been subject to emission control devices in the same way as gasoline powered engines because of their rather small share of the total emissions. As seen in Table 22, that share will become significant by 1985, as emissions from other sources are reduced. It is estimated that the introduction of new emission standards on all new diesel-powered trucks, and on other diesel engines in the Baltimore region (or any urban area), could reduce hydrocarbon emissions from those sources by up to 50 percent.

Relocate Truck Traffic from Region - Diesel truck and bus movements through the region, while producing only a small part of the diesel and shipping emissions, could be reduced by the construction of a circumferential highway around the region. This factor is addressed under the transportation policies described for "automotive" sources. It is estimated that this measure, which could have significant side effects in terms of inducing more travel in areas adjacent to the region and which obviously presents some critical planning and cost questions, would have small impact on diesel VMT and it would not be justified on the basis of this scale of impact. This approach was, therefore, not considered in assessing the degree to which this category of emissions can be reduced.

Episodic Controls - While not considered viable as a strategy to reduce total emissions, episodic ban on non-essential truck travel has the potential to reduce the hydrocarbon emissions from diesel trucks by an estimated 80 percent during critical periods. A ban of this kind would exclude emergency and "essential" vehicles and would allow for travel through the region.

Control Aircraft Emissions - Measures for the reduction of hydrocarbon emissions from aircraft beyond the emission reductions proposed by EPA for 1979 and 1981 are limited. The most significant measures involve:

(1) Reduction of flights,

(2) Use of larger, cleaner aircraft,

(3) Reduction of ground maneuvers, and

(4) Control of non-aircraft ground sources.

Reduce Low Speed Running of Engines - Changes in procedures to limit emissions resulting from ground maneuvers are currently being introduced in airports around the country. These changes involve such measures as taxiing on two or less engines, towing of aircraft by ground vehicles, reduction in engine "run-ups," elimination of non-essential taxiing operations and introduction of mobile lounges. It is estimated that these measures could result in a reduction of 10 percent in hydrocarbons emitted by aircraft on the ground, which is approximately 15 percent of the total emitted by aircraft at BWI.

Reduction in Emissions Due to Ground Equipment - The ground equipment and airport-generated vehicular traffic together generate approximately 30 percent of all pollutants at the airport; this can be reduced by the following methods:

(1) Installation of control devices on fuel-handling equipment at the airport to prevent spills and evaporation,

(2) Limitation on movements of ground support vehicles, and

(3) Limitation on access to the airport by automobiles.

Of these methods, the last could be substantially improved when the proposed rail transit connection to the airport comes on line. The effectiveness of these measures is estimated at 20 percent for this category.

MEASURES TO REDUCE EMISSIONS FROM AUTOMOTIVE SOURCES OF HYDROCARBONS

Light Duty Vehicles (LDV)

The probable emission reduction for each measure is determined by multiplying the midpoint of the range of effectiveness, shown in the matrices in the body of the report, by the percentage of emissions attributable to that source. In the case of LDV, 17 percent of the hydrocarbon emissions are projected from that source in 1985.

Measures to Reduce Automobile Ownership - Second and third car ownership is a variable in the determination of modal split and travel demand. If second and third car ownership can be curtailed, total VMT can also be reduced. Auto ownership could be made more expensive by applying additional tax on new vehicles, either in the form of an excise tax on purchases, a tax on registration through registration fees, or a tax directly on the ownership through personal property tax increases. Each of these methods, if on the order of $500 to $1000 per vehicle per year would discourage second car ownership and marginal car ownership. Assuming that this expense would induce a response similar to that forecast in the I-66 study in suburban Washington, D.C. through a $2.00 per day parking tax (a comparable additional annual levy on the automobile owner), a five to ten percent reduction in VMT could be expected.

Measures to Reduce Total Automobile Travel - A prime means of reducing hydrocarbon emissions is to reduce the total amount of automobile travel occurring daily in the region. There is a range of measures and policy instruments available to contribute to such a reduction, some of which, it will be noted, result in a decrease in all vehicle travel, including heavy duty and diesel vehicle travel. Such measures include:

Divert Auto Passengers to Public Transportation -

(a) Major improvements in level of transit service - Improvements to the level of transit service have been shown to be effective in increasing ridership. By improving the reliability of the service, by increasing the frequency of operation, and by improving comfort and safety, increases in transit ridership may be attained. New lines (bus and rail), more vehicles and drivers, more comfortable vehicles, scheduling more responsive to the needs of the riding public, innovative scheduling techniques (such as Dial-a-Bus), new technologies, and other additions to the service provided can make the transit system more attractive than the automobile for certain types of travel. Busways and exclusive bus lanes can also help to make bus transit as fast as automobile travel.

Many cities have improved transit facilities by expanding service or by providing better facilities for that service. Washington's Shirley Highway busway has resulted in substantially more frequent, more rapid service which has resulted in increased ridership and reduced traffic in the Shirley Highway corridor. Busways in use in other cities have similarly helped to speed transit routes and increase ridership. The recent I-66 study, previously referred to, suggested a five to six percent increase in modal split in favor of transit. Baltimore has already programmed a large public investment in improved transit. The Phase I, 28-mile Metro system will begin operation some time during the period under study. A Phase II expansion tripling the size of the initial system is also under consideration. Plans are under study to orient the bus system around the rail lines to act as feeder collector-distributor lines. These improvements should increase regional transit usage. Other improvements are possible, including additional rapid rail lines and particularly, an extensive additional system of bus routes. New technologies may also be explored. Local distribution systems could be integrated with the rail rapid system in existing centers and in the new centers of activity which are proposed for the transit corridors.

Experiences in other cities indicate that improvements to bus systems of the type discussed above may result in increases in ridership of 10 to 25 percent. This reflects possible reductions in automobile VMT of five to ten percent. In order to determine more accurately the results of any massive changes in the Baltimore region transit system, existing BREIS-related transportation models should be used. By establishing a specific improved transit system in combination with other policies discussed in this report, an application of the BREIS models could determine the resulting increase in transit usage. Several alternative levels of improvement might be tested to determine the most effective program of improvements. For the present study, the five to ten percent reduction in VMT will be used as a measure of effectiveness.

(b) Reduce public transportation fares - Another method of attracting additional ridership to mass transit and hence away from the automobile is the reduction in the cost of the transit trip. By reducing the fare to some lower level, perhaps to zero, persons planning trips may be induced to made them by public transportation rather than by automobile.

The relationship between lower transit fares and ridership has not been well tested. In the past, information on fare increases was generally the only type of data available; thus studies of fare level drops were generally not possible. Few cities have reduced fares. Atlanta dropped fare levels from 35 to 15 cents and experienced a 19% increase in ridership. (A 30% increase in ridership was forecast for reduction to free fares). Seattle has achieved large increases in ridership within the area served by its free downtown bus service. A further verification of these studies can be noted in the "I-66 Corridor Transportation Alternates Study" which suggested a six to ten percent increase in the forecast transit modal split with a fifty percent reduction in transit fares. It should be noted that new riders attracted by fare reductions will not all be former automobile riders, but may to some degree include youths, senior citizens, and others who did not previously travel by automobile.

In Baltimore, transit ridership in the peak hour is forecast in the BREIS report at 20% of total travel. Thus, potential increases are conceivable in transit ridership. However, because of this low level, the reliance upon the automobile is fairly strong and large inducements would be necessary to change these conditions.

This measure would have its maximum effect in reducing VMT if transit fares were reduced to zero and if all new ridership represented individuals who formerly drove an automobile. Under these extreme conditions, if the 30% ridership increase forecast for Atlanta with free transit could be achieved in Baltimore, the percentage using transit during the peak hour would increase from 20% to approximately 26%. This would represent a six percent reduction in VMT if all new riders were former auto drivers. If fares were not eliminated totally, or if some of the new ridership were not auto drivers, the reduction in VMT would be smaller.

While this represents a reasonable estimate of the maximum potential effect of reducing transit fares to zero, this measure would be better tested through the application of more sophisticated transportation models. By applying the mode choice models developed for use in the BREIS study, the effect of this measure could be measured using data based on travel behavior in the Baltimore area. Further, other fare reduction policies could be tested and the specific effect of these policies could be better determined. For the purpose of this study, a two to five percent effectiveness will be used.

(c) Increase downtown parking costs - Any increase in the cost of downtown parking will increase the out-of-pocket cost of automobile operation. This cost must be made sufficiently high if it is to have a large measure of effectiveness. Parking charges in downtown Baltimore today may reach $500 per year and, while this may deter many, there continues to be a large residual demand from those who consider this tolerable. It is estimated that taxes which increase the cost to around $1,000 per year would be required to bring about an appreciable reduction in VMT.

In the I-66 study forecast modal split increase of six to ten percent in favor of transit with the theoretical imposition of parking costs by $2.00 per day. Raising the cost above $1,200-$1,500 per year would be expected to eliminate all but the truly auto-captive person.

Measures to Reduce the Number of Eligible Drivers - Reducing the number of eligible drivers by one or a combination of the methods described in the following paragraphs offers an additional opportunity to reduce auto travel. A policy of instituting more stringent and periodic driving tests would work in a number of ways. Periodic testing would have a nuisance factor which would discourage casual and occasional drivers from renewing their licenses. More stringent tests would reduce the number of persons able to drive. These methods have secondary safety implications, though it must be stated that the effectiveness of the measure in reducing automobile travel will be small, certainly in the zero to two percent category in the evaluation matrix.

A more liberal use of license revocation for multiple violations or selected types of violations, would reduce the number of licensed drivers on the road. This would result in an additional minor reduction in automobiles on the road, though it is more likely to be justified on the basis of safety than of air quality.

The current allowable age for drivers license is 16 years of age in Maryland. If the age limit were raised to 18, as in many states, the number of licensed drivers would be reduced in proportion to the number of 16 to 18 year old drivers, thus reducing the total VMT by a proportional amount. Estimates of the proportion of drivers in this age group is 6.2% assuming the drivers in the 16 to 18 to 62 age groups are equal to the total population on those age groups.

Measures to Make Highway Travel More Expensive - Introduction of new fees and taxes on travel and fuel can make highway travel more expensive. Any increase in costs associated with auto travel will tend to decrease the amount of auto travel. These charges can take the form of tolls and of taxes on fuel. The impact will be limited to a 2 to 5 percent increase in transit modal split resulting from a fifty percent increase in out of pocket expenses.

Measures to Reduce Peak Period Automobile Travel - The a.m. peak period is the most critical to the production of photo-chemical smog because hydrocarbons produced during those hours are subject to maximum exposure to sunlight. Furthermore, meteorological changes occurring at night tend to bring about air mixing and the introduction of clean air. Measures which result in the reduction of hydrocarbon emissions during this part of the day are critical to the maintenance of standards. These include:

(a) Keep a Proportion of Vehicles off the Road Each Day - Institution of a 40-hour/four-day work week will result in a reduction in total VMT by reducing the total number of work trips per employee per week. Instead of the ten trips per week required under conventional scheduling, only eight per week would be necessary. If the program were implemented fully on a regionwide basis with full staggering of employee working days (the work week for each group being Monday - Thursday, Tuesday - Friday, Wednesday - Saturday, etc.) a reduction of 20% in work trips would occur each day. Because 40% of total peak hour VMT is accounted for by work trips, full implementation would result in a maximum VMT reduction of eight percent. However, it is unrealistic to expect that this maximum can be achieved. Some employers would be unwilling or unable to adopt such a schedule. Further, for those who did, there would be an increase in leisure and other non-work trips by employees such that the net reduction in VMT would be significantly less than 8%. For Baltimore, the government activities in Towson and the Social Security Center are potential candidates for a four day work week.

(b) Spread the Peak Period Travel by Staggering Work Hours - While the staggering of work hours itself will not result in a reduction in total daily VMT, changing of starting times such that employees would be making their working trip outside of the peak period could result in a substantial reduction in VMT during the 6:00-9:00 am.m period. Presently, approximately equal amounts of traffic occur in each hour of the existing three hour period. Thus, about 30% of the work trip traffic could be shifted out of that period without resulting in a mere shifting of the peak period to a different period (7:00-10:00 a.m., for example). Because many of the trips will still occur in the 6:00-9:00 a.m. period, the reduction in work trip VMT would be at best about 25% during the peak period for the largest possible staggering. Because work trip VMT is approximately 40% of total peak period travel, a reduction of approximately 10% in peak period VMT could occur, assuming full implementation.

This strategy has not to date been implemented for the express purpose of improving air quality, although, on a limited basis, it has been tried by large employers, most notably government agencies, to achieve some relief in peak hour traffic congestion. As in the case of the four day/40 hour work week, major government employers in Baltimore, accounting for about 10% of the regional labor force, would be the most likely leaders in undertaking staggered working hours. If this proportion of the labor force were involved, the maximum reduction in VMT would be approximately 1%, providing that no new non-work trips were undertaken in the peak period, and providing that any resultant relief in peak hour traffic congestion did not induce new automobile work trips to tak place.

(c) Initiate Centralized Carpooling Information System - During the winter of 1973-74, energy crisis centralized carpooling systems were instituted in most major cities. These systems matched potential drivers and riders via computer. Although this in and of itself is of small incentive to increase auto occupancy, when couupled with other incentives (parking and fast-leave incentives) and with disincentives, this facilitates carpooling and increases the probability that carpooling will occur. The estimates of effectiveness assume that these instruments are jointly applied.

Measures to Restrict Travel in Summer Months -

(a) Coordinated Vacations - It is a recorded fact that a.m. peak VMT drops slightly during the summer months as a result of the concentration of vacation time into this period of the year. If vacations could be restricted so that even more occurred in the 16 week summer period of maximum risk of air quality deterioration, an appreciable improvement can be achieved. Assuming a 40% work, 60% non-work split during peak period; two-week vacation; and 1/4 of the vacationers leave town then a 6% reduction in a.m. peak VMT could be achieved (12.5% x 40% = 5%; 25% x 12.5% = 1.875%; 5% + 1.875% = 6.875%).

(b) Seasonal Rationing Programs Could be Instituted to Reduce Hydrocarbon Emissions during the summer months when the photo-chemical reaction is most likely to occur. All three types of rationing discussed above with the listed could be qualifications as to feasibility and effectiveness, applied as part of the program. Transit service should be improved in the summer if a rationing program were instituted. Currently, during the summer months, public transportation service is cut back because schools are closed, passengers are on vacation and because it is the transit employee vacation period. However, this is the period of the year when it is most critical that automobile utilization be reduced to a minimum. A method to encourage maximum use of public transportation would be to maintain and, if possible, enhance levels of service at this time of year.

Measures to Restrict Travel Year Round - Year-round fuel rationing may take different forms. Limitation of the amount purchased in a specific period by individual automobile owners is of questionable feasibility on a regional basis because it raises matters of equity with regard to other regions. Other forms of rationing may be more effective. The rationing of fuel to the retailer or wholesaler, similar to the 1973-74 winter allocation program, can do much to reduce travel. The third form of rationing, economic rationing could also reduce travel. This method is, of course, highly regressive because it would be in the form of major gasoline tax increases. Each of these rationing forms would require improvements in alternative modes of transportation if economic disruptions are to avoided. Rationing will be relatively ineffective unless the rationed area is sufficiently large to discourage driving out of the region to obtain gasoline.

Measures to Relocate Travel Outside of the Region - Some of the travel in the region is due to traffic originating from and destined for places outside of the region; a decrease in regional hydrocarbon emissions could be achieved by diverting this traffic around the region. Much of this traffic uses I-95. Significant diversion of this through traffic could be accomplished only by the construction of a major interstate roadway to allow total bypass of the AQM region. Although intercepting long trips and therefore, having a relatively large impact on VMT reduction per trip, the percent of through travel is so small during the a.m. peak that this measure would be expected to have minimal impact on total VMT reduction. In fact, it must be stated that the additional accessibility provided to parts of the outlying areas of the region could well result in additional development and additional travel above and beyond that which would otherwise occur. The extent of changes, both in reducing through traffic and in inducing additional travel must remain speculative without systematic testing.

Measures to Make Highway Travel Less Convenient and Less Comfortable - By restricting highway construction and improvement, travel would become less convenient and less comfortable. The demand for travel generally would be lower by restricting the supply of highways within the region, and the amount of travel would be reduced. The traffic projections on which the calculations of air quality were based reflect large increases in the highway network. By reducing the amount of new highway from this level, less travel would result. While there are no data on the effect on travel of closing existing highways, other studies have indicated that the construction of new facilities leads to an increase in traffic over that which would occur without those facilities.

Plans in the Baltimore region call for the construction of an extensive network of new freeways and major arterials. The "3A System" of Interstate Highways within Baltimore City and the General Development Plan system proposed by the Regional Planning Council represent a major increase in the supply of highways in the region. The effect on travel of nonconstructing either the 3A or GDP systems within the Baltimore Region has been measured as part of the travel simulations performed for the BREIS study. In 1995, 4% less traffic is forecast to occur in the peak hour if the 3A system is not constructed. Alternative 8--the 3A system but not the GDP system--has 12% less peak hour travel that the full network while Alternative 9, neither the 3A nor GDP systems, has 17.8% less travel in the peak period than the full network. Similar percentage decreases in travel would occur in 1985 for each Alternative if the systems are not constructed.

In order to better measure the effect of a given highway system on regional travel in 1985 for the purposes of this study, the various models run as part of the BREIS study for 1980 and 1995 would have to be run for 1985 given the conditions in effect at that time. The level of transit service available, land use and population considerations, and other policies expected to be in effect at that time would have be included. The scope and scheduling of the trial maintenance plan do not permit use of this preferred methodology; for the purposes of the current study, it has been assumed that similar percentage decreases in VMT will be attained in 1985 as in 1995. The shortcomings of this assumption are recognized; it may be a liberal estimate of the effectiveness of the measure.

Measures to Reduce Gasoline Consumption - The amount of fuel burned and the efficiency with which it is burned are both factors in hydrocarbon production. Measures to reduce gasoline consumption and increased efficiency will result in reduced emissions.

(a) Decrease non-essential accessories - The institution of a heavy tax on accessories would reduce the number of auto accessories and increase the mileage of auto engines. Of prime importance is air conditioning. However, power brakes, power steering, and other secondary users of energy contribute to less effective gasoline use. Many of these luxuries have become regarded as essentials and, again, heavy taxes, perhaps of the order of $500 to $1000 per vehicle would be required to bring about any significant reduction in demand.

(b) Modify engine type - When electric engined automobiles become a production reality less energy will be used than gasoline powered automobiles by a factor of approximately 50%. Furthermore, only a portion of the electric power used will be generated by fossil fuel plants and this could well occur outside of the region. Therefore, less hydrocarbon esissions would be involved in powering electric automobiles and much less than this amount would occur in the Baltimore AWMA. One further advantage is that emissions generated per unit of energy at the stationary power plant are easier to control and easier to monitor than are emissions at the automobile exhaust pipe.

Measures to Promote Optimum Traffic Flow - Through highway and signalization improvements, by increasing the average speed, and by reducing the amount of stop and go travel and other inefficiencies in the highway network, the rate of emissions per VMT may be reduced. Program of this type include various improvements to signalization, intersection design, parking restrictions and roadway improvements and are especially applicable to arterial routes. Also available are various techniques for improving the flow of traffic on freeways such as driver information systems, ramp metering to allow only as many cars on a section of road as can be handled and various projects to improve the configuration of the highway. System-wide changes are also possible such that traffic is assigned to its optimum route by application of these techniques. In this way, a network may be modified to operate as efficiently as possible.

Programs of this type have been proposed as parts of State Implementation Plans for various cities in the United States. Most cities are also undertaking traffic flow improvements under the TOPICS (Traffic Operations Program to Improve Capacity and Safety) Program. Small scale intersection or roadway improvements generally fall under this program. Cities with extensive freeway systems such as Chicago or Los Angeles have also applied freeway surveillance, driver information systems, and ramp metering in order to increase the efficiences of these systems.

In Baltimore, a large commitment to traffic flow improvements is already underway. The EPA-promulgated Transportation Control Plan calls for a decrease of emissions of hydrocarbons of 4.3% of the base year as a result of the application of TOPICS and other flow improvement measures. Considering the existing TCP, it would appear that no further improvements of this type are possible in Baltimore. Thus, the effectiveness of this strategy would be felt throughout the period under a study although as traffic increased, its effectiveness might be reduced.

Any improvement during the period under study could best be tested by a study of any possible areas within the region for improvements. Because of the spot nature of projects of this type, a survey of the region's highway system would be required to determine possible locations for these improvements and a detailed study of each site would be required to determine the amount of improvement that each project could individually accomplish.

Measures to Increase Auto Occupancy -

(a) Parking incentives for car pools - In large employment centers with relatively large parking facilities, parking incentives can increase carpooling and auto occupancy. Parking incentives can take the form of reduced rates, reserved spaces or lots, late arrival or early departures, or a combination of all three.

(b) Use of express lanes for carpools - Express lanes, normally reserved exclusively for buses, can be opened to carpools. This incentive will greatly decrease the travel time for the carpool, thus encouraging higher auto occupancy rates.

(c) Tax and insurance incentives for carpools - Monetary incentives, such as tax redctions and insurance premium reductions act to increase auto occupancy.

Each of these measures can be expected to only have only minimal effect on auto occupancy. Each taken separately would likely have an effectiveness of 0-2% reduction in VMT; collectively, they might reach as high as 2% reduction in LDV VMT. When combined with other measures to reduce VMT, a 1% effectiveness could be expected.

Measures to Reduce Emissions Per Mile - Episodic control on automobile travel. Enforcement of periodic bans on auto travel would reduce automobile travel during episodes of high pollution. This measure would be very effective although there are obvious economic problems and enforcement questions. Like other episodic measures, this is regarded as an available supplementary tool to be applied in the event that other measures are not adequate to solve the problem.

A system of auto stickers which indicate the essential nature of travel based on occupation, family size, and other factors would assist in the enforcement of partial bans on driving. A truly arbitrary odd-even ban on driving could also be instituted during air pollution episodes.

Emergency holidays for public employees. The use of emergency holidays for public employees would reduce the a.m. peak travel in direct proportion to the government employment. In areas of major public employment, such as Baltimore, this would be extremely effective. (There were an estimated 156,000 public employees in the region of a total employment of 869,800, or about 18% in 1970).

As with the public employees, provision of emergency holidays for private employees would directly decrease emissions during episodes.

Heavy Duty Vehicles (HDV) - The emission reduction for each measure is determined by multiplying the midpoint of the range of effectiveness times the percentage emissions from that source. In the case of HDV, 42% of the hydrocarbon emissions will come from heavy duty vehicles in 1985.

Measures to Reduce Total Truck Travel - As with light duty vehicles, engine running time (therefore, total truck travel), is the prime determinant of hydrocarbon emissions.

Measures to Reduce Truck Ownership - Private and corporate truck ownership can be restricted through the following measures:

(a) Make truck ownership more expensive by applying additional tax on new vehicles. This may take the form of an excise tax on purchases, a tax on registration through registration fees, or a tax directly on the ownership through personal property tax increases. The level of taxation in mind is $500-$1000 per vehicle. Such charges could result in a small decrease in truck ownership as vehicles are used more efficiently by keeping them on the road for longer hours. The impact on VMT would be even less since most trips involve distribution of goods which must be moved anyway. The savings would be in elimination of less-than-essential trips, but would be marginal since the additional costs, as business expenses would be passed on to the consumer.

(b) Reduce the number of eligible trucks by instituting a strict vehicle inspection system. This policy instrument would reduce the number of trucks which would be allowed to operate and it would also tend to eliminate older heavy duty vehicles from the inventory.

Measures to Reduce Gasoline Truck Ownership - The application of fees and taxes to HDV would, as with light duty vehicles, increase the cost of owning and operating such vehicles. The impact of this measure would be limited, but it would certainly result in the elimination of some non-essential trips. Although the tendency would be to use trucks more intensively, there would not necessarily be a resulting reduction in VMT. The effect of this policy instrument could be minimal.

If the taxes and fees imposed were applied to gasoline vehicles only, other types of engines (diesel and electric) would become more attractive. The amount of reduction in hydrocarbon emissions would depend on the type of replacement vehicle used.

Reduce total HDV VMT - Although relatively localized, the prohibition of truck movements in certain areas of the region will produce "truck-free" zones and result in small decreases in VMT and emissions.

Public transit vehicles for the carriage and movement of goods could also be utilized in off-peak hours. Because buses and rapid transit carriers are not as fully occupied in the off-hours of the day, they could serve to transfer intracity or intracounty parcels, such as mail moving from one substation to another. This could reduce the number of truck trips made during the day in the region. This idea has been suggested in other cities; however, there is no record of its use as a technique to improve air quality. For Baltimore this measure could be applied to the intraregional movement of mail, government correspondence, and bulk newspaper delivery. Mail movement would, of course, require the use of a secure container or compartment on MTA vehicles.

This measure is limited in its potential effectiveness in reducing a.m. peak hour VMT for several reasons. Firstly, it deals with trips in the off-peak hours. Secondly, it deals only with a small part of all truck movements within the region. These measures can be expected to have only minimal effect on total HDV VMT.

Optimize routes and schedules - Care in the selection of truck routes and schedules for deliveries could eliminate wasted mileage and avoid congested, stop-and-go traffic. The responsibility for implementation of this measure lies chiefly on private business, but they could be assisted by better definition of truck routes on the part of local and regional agencies.

Measures to Reduce Peak Period Truck Travel - Hydrocarbons produced by truck movement in the 6:00-9:00 a.m. peak hour are the prime concern, because this is the period in which hydrocarbons emitted have the longest exposure to sunlight and hence the greatest propensity for production of photo-chemical oxidants. Means of controlling these emissions include the prohibition of use of selected streets to truck traffic at selected times of the day. This type of prohibition would not only discourage a.m. peak truck travel, by creating inconvenience to the truckers, but if truck traffic were prohibited from congested thoroughfares in general and to delivery activities in particular, total truck VMT would be reduced during the a.m. peak and auto traffic would flow more easily, thus reducing hydrocarbon emissions. Baltimore currently has restricted loading zones. An attempt to further restrict truck movements results in considerable public reaction and caused special problems for the U. S. Postal Service. Any additional restriction can be expected to be politically controversial.

Modify engine type and size - Replacement of gasoline engines by electric engines, especially feasible in the case of light duty vehicles, could substantially reduce energy consumption and the emission of hydrocarbons. As noted above, however, technology has not advanced to the point of mass production of this type engine. Smaller engine size for many trucks could be implemented more readily and, given the over-powered nature of most heavy duty vehicles, this could be done without sacrificing the capability and utility of trucks. Smaller engined trucks would be encouraged through the use of a tax by engine displacement, thus replacing HDVs with LDVs.

Measures to Reduce Emissions Per Mile - Installation of pollution control devices will reduce emissions per mile. Heavy duty vehicles have not been subject to the same pollution control standards as light duty vehicles, and control of emissions has, as a result, been minimal. This is regarded as potentially the most productive new measure available for reduction of hydrocarbon because HDV's are a heavy source of pollution. In 1973, HDV's produced 12.61 tons (21.9% of the regional total) in the peak 6:00-9:00 a.m. period; by 1985, it is estimated that this will have decreased to 10.11 tons; however, by that year, this will represent 41.5% of the regional total. Any significant percentage reduction will be very important in reduction of regional totals. It is estimated that at least 50% of HDV hydrocarbons could be eliminated by this means, but only if state implementation of a retrofit program is instituted.

Federal standards could be made more strict or Federal law could be changed to allow stricter state standards. This approach must be coupled with with the installation of pollution control devices through the provision of legal requirement that such devices be installed.

Measures to Reduce Truck Travel During High Pollution Periods - A ban on nonessential truck travel similar to that suggested for automobiles during high pollution episodes would result in an effective reduction in truck movements and hence, of hydrocarbon emissions. In the evaluation of the matrix, this measure has been rated at around 50% effective. This is, however, clearly an assumption as to the proportion of gasoline trucks which may reasonably be expected to be kept off the road for the few days in each year when pollution episodes are likely to occur. Also, a sticker system, as discussed previously, would produce proportional results during high pollution episodes.

Emergency holidays could also be designated for private and public employees. Such emergency holidays would not only reduce truck travel by giving drivers holidays but would reduce deliveries and other HDV activities.

It must also be noted that many of the measures will be effective only when parcelled with others. Perhaps the prime example of this is the combination of transportation and land use measures. The following paragraphs present an example of how the effectiveness of this coupling of measures may be estimated, a coupling which produces a land use pattern which is conducive to reduction of automotive travel and a transportation system to properly serve it.

Land use measures assumed to be available for the purpose include:

(1) Zoning,

(2) Agricultural/conservation zoning,

(3) Planning unit development and cluster zoning,

(4) Special use permits,

(5) Holding zones,

(6) Open space land requisition and landbanking,

(7) Floating zones, and

(8) Discretionary taxation policies.

Land use and development controls have not been used to date for the exclusive purpose of achieving better air quality. However, many of these controls have been applied to achieve desired land use patterns which subsequently led to less traffic congestion and lower emission levels.

Each of the jurisdictions within the Baltimore region is concerned about growth. For example, Baltimore City would like to retain its population and attract new residents while outside Baltimore City the suburban jurisdictions are looking for tools to control and channel growth. Consequently, application of these development controls to achieve improved air quality in the Baltimore region could be received as being generally in accord with existing growth control proposals.

Concentration of development in mass transit corridors would tend to reduce VMT in several ways, as follows:

(1) Work trip VMT is reduced because of the availability of mass transit.

(2) Average work trip length is reduced for auto drivers from what it might be given spread development.

(3) Intensity of development within corridors affords opportunities for multi-purpose centers and PUD building concepts, which can further reduce the total number of trips, length of trips, and the need for auto use.

The most important of these factors is the reduction in work trip VMT which is absolutely critical to reducing auto-generated emissions. In order to demonstrate the relationship of VMT and the change in the pattern of development resulting from application of the strategies discussed above, population and employment were reallocated among RPD's in the Baltimore region for the period 1973 to 1985. This allocation was based on a definition of mass transit corridors. The procedure assumes an increased density of population within the residential acres added between 1973 and 1985 as a result of these strategies for RPD's served by rapid transit.

Additional population for these "growth" districts was shifted from areas not served by rapid transit. Employment increases projected in "non-growth" districts were also reallocated to the "growth" RPD's. It must be emphasized that this analysis is not intended to suggest a goal for regional growth, rather it is intended only to demonstrate the general method in which a program of centralized development could [illegible] to reduce VMT.

For the purpose of this analysis, six corridors were defined. These were:

		RPD
(1)	Anne Arundel County	201,202,203,204
(2)	Social Security	323
(3)	Ownings Mills	313
(4)	Towson	308,309,315

(5) NE Industrial Corridor	316,317,320
(6) Sparrows Point	328,329,330,331

In addition, four RPD's within Baltimore City were assumed to grow more intensely than RPC modeling procedures had forecast because of the strategies availability through rapid rail transit. These districts are 101, 103, 113, and 114.

Reallocation of population from "non-growth" districts to those identified above was based on several assumptions. These assumptions included:

(1) New residential acres expected between 1973 and 1985 would be developed at higher densities than previously forecast for districts served by transit. For these incremental acres a density of 35 persons per acre was assumed. This increased density, although three times the residential density typically forecast by RPC, is considered a moderate density, which could be attained by garden apartment or townhouse development.

(2) The growth rate in Baltimore County is generally less than the growth rates forecast in the Baltimore-Washington Corridor and the Annapolis (Route 2) Corridor. Consequently, proportionately less forecast new population was diverted from the 200 and 600 series RPD's than from the 300 series RPD's (Baltimore County) based on the assumption that these strong growth trends would be more difficult to control.

(3) Only new population and employment growth forecast between 1973 and 1985 was considered for reallocation.

Reallocation of employment from "non-growth" districts to those in the transit corridors was based on one primary assumption, i.e., total new employment forecast in "non-growth" districts was assumed to be distributed among "growth" districts in proportion to the additional growth in population resulting from the population reallocation described above.

The results of this analysis indicated the change in population in each RPD as of 1985 as a result of the reallocation of population as a result of the strategies of land use and development control. A total of 133,314 persons were assumed to have been reallocated from districts not served by transit to those within the transit corridors for 1985. As a result of the reallocation, 34,450 jobs were reallocated to transit-oriented zones.

In order to measure the change in regional peak hour VMT which would result from the implementation of the land use and development control strategies, the following relationship was developed:

$$\text{Change in VMT} = PwWAMTp - EWAMT + PwWA'M'Tp + EWA'M'Tp.$$

where:

P = number of persons reallocated to transit related zones;
w = number of employees per person;
W = number of work trips per employee;
A, A' = number of auto trips per work trip;
M, M' = length of auto trip;
T = ratio of total travel to work travel;
E = number of employees reallocated to transit related zones;
p = proportion of work trips in the peak hour.

Of these values, the following remain constant with the land use change:

$w = 0.40$ employees per person;
$W = 1.56$ work trips per employee;
$T = 2.5$ total travel/work travel;
$p = 0.30$ work trips in peak hour/total day work.

Because the population reallocation to transit related zones will have a greater propensity to use transit given its greater convenience and proximity in these zones, the variables relating the number of automobile trips per work trip will be valued at:

$A = 0.61$ auto trips per work trip (1985 regionwide forecast value-BREIS report);
$A' = 0.40$ auto trips per work trip.

Because the zones into which population and employment were reallocated are much more centrally located than the zones from which they were allocated, shorter trip lengths will result, as follows:

M = 4.2 miles (reflecting one-half of the average trip length because it is applied to trips generated by population and attracted by employment);

M' = 3.0 miles.

Substituting these values, as well as the amount of population reallocated (P = 133,314) and employment reallocated (E = 38,450), a change in total regional travel during the peak hour (change in VMT = 146,248) was the result.

Based on 1985 total peak hour auto travel of 5,017,330 VMT, this represents a VMT reduction of 2.9 percent in the peak hour by 1985.

APPENDIX G

DESCRIPTION OF IMPACTS FROM LAND USE AND TRANSPORTATION MAINTENANCE MEASURES

LEGAL IMPACTS

The police power as delegated from the state is the constitutional basis for many land use controls at the local level, including that of zoning. It is similarly the basis for special use permits, planned unit development, and other techniques involving public control through ownership such as open space acquisition, all of which can be used to further a development pattern consistent with the objectives of air quality management. Use of the controls for air quality management per se has not been attempted in the Baltimore region nor in the State of Maryland; rather, the jurisdictions have been concerned with the issue of growth as related to the location, intensity and timing of development, the efficiency of public services, and the preservation of prime agricultural land. Land use policy should not, of course, be based on one criterion. Yet, as air quality management enters the planning and regulatory processes, denial of special use permits on the grounds of potential high emission sources or rezonings to attain higher densities in transit corridors may lead to court challenges on this issue. The use of land use controls for air quality management will require regional coordination, local regulation, and may also require state enabling legislation as deemed appropriate by the State's Attorney General. At the state level, intervention in areas of critical state concern and the nature of state intervention as required in recent state land use legislation.

Legal issues raised by the alternative hydrocarbon strategies are:

(1) Is state enabling legislation required for localities to implement land use controls for the purpose of air quality maintenance?

(2) How will the air quality maintenance plan be enforced if and when local land use controls are challenged or where localities themselves wish to deviate from commitments to the plan? It is assumed that agreement will be reached among the jurisdictions in the Baltimore region prior to the implementation of the plan, that the

legal authority to implement the plan will be adequately delegated to the localities and that monitoring and enforcement will be vested in the appropriate state agency.

(3) When revisions to a local comprehensive plan or general zoning plan are necessitated by the air quality maintenance plan, will a state EIS be required to demonstrate conformance?

(4) What state and federal tax revisions are required to provide equity to landowners when future development has been precluded in agriculture/conservation zoning?

(5) Can state highway funds (saved in the withholding of construction funds) be diverted to mass transit programs? Is legislative action required?

(6) Does air quality maintenance provide too much discretion for local jurisdictions in the exercise of zoning? Will rigorous criteria be required in zoning cases to avoid the appearance, if not the reality, of classifications being arbitrary and capricous? Will the use of large lot zoning in agricultural districts be challenged as exclusionary?

(7) If enforcement of air quality maintenance plan means serious adverse effects on other elements of the environment how would resolution of the conflict take place--administrative or judicial relief?

The legality of the proposed measures, the administrative procedures used to enforce them and actions which must be taken by state and federal government to permit them to be implemented are raised as questions; resolution of these issues is certainly complex and, in several instances, more general in scope than the Baltimore region. It is believed that they cannot be properly addressed in the current study but should be given urgent attention by EPA for the reason that the timing and effectiveness of maintenance actions nationally depends upon their resolution.

ECONOMIC IMPACTS

Major economic impacts are tied to plan proposals for changes in the regional transportation system from highways to public transit. A proposed halt in construction of the Interstate system would affect some $1 billion of capital expenditures, federal, state and local. Not all of this amount will be "savings" since additional improvements are proposed for the transit system; these have not been precisely defined nor costed out, but could be of the order of $200 million over a 10 year period, substantially less than the capital expenditure savings from the halt in expressway construction.

The diversion of travel demand from automobile to public transportation, would result in less automobile use and less automobile ownership, with resulting decreases in public revenues from automobile taxes, gasoline taxes and registration fees.

Acting to increase public revenues would be taxes instituted on automobile use and on automobile accessories. Neither of these have been precisely quantified, but using the same assumptions as were used in developing probable levels of effectiveness in reducing hydrocarbon emissions, it is estimated that there would be a net decrease in tax revenues of the order of $6 million per year.*

The diversion of travel demand to transit is predicated on fare subsidies, among other measures. This will be a major public expense, of the order of $50 million annually by 1985. In fact, transit would not be "free"; the net effect would be one of spreading the costs of the system across the whole of the regional community rather than requiring users to meet operating costs. The "redistributional" effect is discussed as a social impact.

The land use policies which are an integral part of the "diversion of travel demand" component of the trial plan will themselves produce certain economic impacts. These will primarily stem from changes in development potential resulting from accessibility changes and land use controls. Inevitably, land values in areas subject to development constraints under the proposed policies will decline in value, while lands at and adjacent to the "centers and corridors" will have enhanced value resulting from new development opportunities, greater densities, and improved transportation facilities. These changes are dependent on market factors and quantification is beyond the scope of the present study.

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* Reduction of $20 million annually in gasoline taxes and of $2 million annually in automobile sales taxes, and an increase of $16 million annually on accessory taxes.

SOCIAL IMPACTS

The transportation elements with more significant social consequences are addressed below:

(1) Restrict highway construction and improvement by withholding highway construction funds. The shift from highway construction to transit improvements will have important economic impacts but its secondary consequences will include some which properly may be termed social. The highway program is construction oriented and the bulk of the expenditures will through the 6 year construction period, create local jobs in the construction industry* and associated activities; the "multiplier effect" of local wages and salaries of these circulate in the community will generate additional service employment. The transit improvement program, on the other hand, is much more oriented to the acquisition of vehicles which are produced outside of the region; these expenditures will produce few construction jobs, though operation of an extended system will generate continuing employment for drivers, maintenance personnel and administrative staff of the order of 2,000 additional permanent employees. If highway funds are withheld, and subsequently transferred to the rapid rail construction program many of the spin offs of local jobs and wages will not be lost from the curtailed highway programs. Indeed, the increased funds for rapid rail could speed the construction progress on the committed transit system and provide opportunities for use ahead of the present schedule.

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* Estimated to be of the order of 20,000 man-years of effort on the $1 billion program.

(2) Diversion of Auto Passengers to Rail and Bus

(a) Improve transit service, subsidize fares and institute user taxes. The importance of these elements is that the auto user, in effect, subsidizes the transit user's costs. For the "captured" auto user, this policy will undoubtedly seem inequitable. The thrust, however, is to attract the user-of-the-automobile-by-choice to the transit alternative. The improvement in service and the lowered fares will have substantial benefits for the traditional captive transit user; the poor, the elderly, the young. For low and moderate income groups, the extension of transit service opens new opportunities for job locations and, at the reduced fares, their expanded mobility will not be costly. The reduced fares, in fact, increase the proportion of their disposable income available for other basic goods and services. Increased mobility for the elderly and the young potentially means greater use of public facilities such as clinics, libraries, and other communitity resources.

(b) Control of land use to concentrate development in transportation corridors. The use of selective land use controls to channel development into higher density transportation corridors will have a variety of social implications. First, an alternative to sprawl development will be found in suburban locations. A higher density and transit oriented way of life can be generated by the mixed use development characteristic of planned unit development near transit stations. The provision of mixed uses near residences affords another change in suburban life style--the opportunity to walk to convenience shopping or combine several purposes in a single auto trip. Higher densities also increases the utility of public facilities and offers the potential of daytime and nighttime use for multiple purposes.

Open space will be generated by the agricultural/conservation zoning, holding zones and land banking. Nonetheless, the availability of usable and scenic open space can have important social benefits in providing recreation, psychological relief and enjoyment. To the extent that agricultural zoning helps shape community limits, the perception of the community can be enhanced.

OTHER ENVIRONMENTAL EFFECTS

The measures in the hydrocarbon alternative plans will, as a secondary effect, reduce other pollutants from transportation sources. The reduction in particulates will reach nearly 2.0 $\mu g/m^3$. Decreases in LDV VMT and the HDV retrofit program will each bring about appreciable reductions in SO_2 and NOx.

Two positive effects and one negative effect of the proposed plan on waste water (sanitary sewers and storm water) collection should be noted. The concentration of urban activities into centers will increase the potential efficiency of waste water collection systems; the areas to be served will be at higher densities and concentrated into more efficiently served corridors, as compared with the highly dispersed, lower density patterns typical of incremental growth in recent years. The decrease in VMT will decrease the automobile and truck generated pollution introduced to the storm water runoff in proportion to the estimated reduction in VMT. The negative impact is that the increased concentrations of urban uses may well increase slightly the total area of impervious surfaces in the region with the result that storm water runoff is increased.

The side effects of the plan with regard to urban noise will also have both positive and negative points. A reduction in VMT will have a direct positive effect on automobile-generated component of urban noise. The concentration of urban activities into more diverse centers will, by contrast, increase the ambient noise levels of the corridors. The measure which would limit growth in the number of aircraft operations at Baltimore-Washington International Airport would result in less noise for two separate reasons. Firstly, the actual number of operations may be expected to be less than if operational levels were unconstrained so that the duration of exposure to aircraft noise would be less, and secondly, the airlines can be expected to utilize larger aircraft in order to meet increasing travel demands within a static number of operations. These large jet aircraft (the D.C.#10 and L. 1011) are quieter than the smaller jet aircraft (B. 727, D.C. #9) which, through the 10-year planning period, would otherwise likely constitute the bulk of the traffic.

The transporation measures will have both good and bad impact on fuel conservation. The direct savings in gasoline resulting from a 30% reduction in VMT will be partially offset by decreased mileage on HDV's as a result of the emission control devices proposed in the plan. This latter effect cannot be quantified but the balance is clearly on a reduction of overall gasoline consumption on a regional basis.

The transportation/land use measures will have a beneficial effect on fuel conservation. A proportional savings in gasoline will result from a 30% reduction in VMT.